U.S. Environmental Protection Agency Region II
Emergency and Remedial Response Division
Response and Prevention Branch

Tutu Well Site
Potable Water Alternatives Report
Anna's Retreat, St. Thomas, U.S. Virgin Islands

Prepared for: Paula A. Cammarata, OSC
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March, 1989

Roy F. Weston, Inc.
Spill Prevention & Emergency Response Division
In Association with ICF Technology, Inc., C.C. Johnson & Malhotra, P.C., Resource Applications, Inc., Geo/Resource Consultants, Inc., and Environmental Toxicology International, Inc.

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1.0 SYNOPSIS

1.1 Summary

On July 16, 1987, the U.S. EPA received a request from the U.S. Virgin Islands Department of Planning and Natural Resources (DPNR) to sample and analyze one well, which exhibited a strong unpleasant odor, in the Tutu area of St. Thomas. This well was used as a main source of drinking water supply on the eastern portion of the island. Subsequently, samples were taken from 6 additional wells which service residential customers in the immediate area. Eventually a total of 24 wells; (14 commercial, 6 private, 3 institutional and 1 public) in the Tutu area, were sampled and analyzed. Also, a total of 123 cisterns serviced by water haulers from this area were sampled and analyzed. Analytical results showed 3 wells with contaminants above the 175 ppb Health Advisory level for PCE and 8 wells above the recommended maximum volatile organic compound (VOC) levels in drinking water. Twenty four (24) well samples showed the presence of 1,2-transdichloroethylene (DCE), trichloroethylene (TCE), tetrachloroethylene (PCE), toluene (TOL), benzene (BEN) and tertbutyl methyl ether (TBME) in concentrations ranging from 61 parts per billion (ppb) to 120,000 ppb. Based on these results, 13 commercial and 5 private wells were ordered closed. Also, 5 cisterns were found to be contaminated. These cisterns were cleaned, disinfected and filled with high quality drinking water.

EPA also conducted a Hazardous Substance List (HSL) analysis on the twenty four (24) wells to confirm the previous analyses. Results of this latest HSL testing showed the presence of additional metal contamination. Three (3) of the wells tested, showed high volatile organic compounds (VOC) and metals concentrations such as arsenic (15 ppb) selenium (15 ppb) and zinc (340 ppb).

Based on prior sampling results, EPA initiated a limited CERCLA removal action by providing water truck deliveries to fill three cisterns. The three cisterns serve an estimated 50 persons in two homes and one apartment complex. On December 3, 1987, EPA initiated a study to consider various alternatives to find a safe and permanent potable water supply for the affected homes. The initial phase of the study is contained herein.

1.2 Conclusions and Recommendations

This report considered the following alternatives:

1. No Action.

2. Extend the existing water main.

3. Install new and deeper wells within the contamination area.

4. Install new wells beyond the area of contamination.

5. Install a whole house reverse osmosis (R.O.) unit at each location.

6. Construct a reverse osmosis central plant.

7. Construct a water treatment plant.

8. Increase the capacity of the cisterns.

9. Install individual activated carbon filters

The alternatives were comparatively evaluated for environmental impact, cost, and their ability to provide a reasonably safe and permanent water supply to the persons with contaminated drinking water wells.

Most of the alternatives meet the cost criteria but failed to provide a safe and permanent water supply without negative environmental impact.

The report found the extension of the existing water main to be the safest and most permanent water supply alternative.

This proposed water main extension will be connected to the existing water main at the intersection of Routes 382 and 38, southeast on Route 38 to the intersection of Routes 38 and 32 (Fort Mylner Shopping Center) and then south on Route 342 to a circle, 700 feet south of the Fort Mylner intersection (see Figure 8-1 page 27). The cost of the water main installation has been estimated at $647,000.

The no action alternative was considered not acceptable and therefore, was not addressed.

The new and deeper wells alternative would pull the contamination further down from the Turpentine aquifer (the major aquifer) into another aquifer in St. Thomas, thus spreading the contamination vertically.
The cost of this alternative has been estimated at $375,000.

The wells drilled beyond the area of contamination alternative would, in the long term, pull the contamination towards their circle of influence and extend the contamination through a greater area, increasing the risk area and affecting more persons. The cost of this alternative has been estimated at $545,000.

The two alternatives involving wells would not provide a permanent and safe water supply, and in addition would also pose a definite threat to other aquifers in St. Thomas.

The whole house reverse osmosis (R.O.) units produce a highly contaminated brine which would pose a great monetary burden on the affected persons because of disposal costs. The cost of this alternative has been estimated at $38,000,000.

The conventional water treatment plant alternative will not effectively remove the selenium from the water, will require full-time 24/hours day monitoring by a water treatment plant operator, and will require the addition of a wide variety of treatment chemicals. The plant is also extremely noisy to operate and may affect the neighbors. In addition, the resultant sludge has to be properly disposed of due to contamination. The water treatment plant requires land acquisition for the installation of an elevated storage tank and distribution piping. The initial cost of this alternative has been estimated at $400,000. and would have ongoing operational costs along with it.

The central reverse osmosis plant at an estimated cost of ($375,000) will convert salt water into potable water and will need an intake structure, a cyclone filter to remove silt and sand particles from the salt water, an elevated storage tank, 8,000 feet of distribution piping, a pump to transfer the treated water to the elevated storage tank, and land for the right of way.

The installation of Activated Carbon Filters at a total estimated cost of ($95,000) will remove the volatile organic compounds (VOC) from the water. However, these filters need frequent sampling to monitor for breakthough, and the columns along with the spent carbon have to be replaced regularly. The carbon slurry produced will be contaminated with VOC's and will have to be disposed of as hazardous waste by the affected people. The carbon (4 cu. ft.) when replaced produces 3-55 gallon drums of VOC contaminated carbon slurry.

Increasing the cisterns volume at an estimated cost of ($360,000), is of questionable reliabilty. The island's rainfall appears to be decreasing so the potential for water catchment is also declining. There does not appear to be sufficient land available to increase the cistern volumes laterally. The only way the volume could be increased is by making deeper cisterns. This operation would require the shoring of the existing homes and apartments, therefore, risking the possibilty of structural damage to these residences.

2.0 SITE DESCRIPTION AND CONDITIONS

2.1 Site Background and Conditions

The Tutu Well site is located at the eastern end of the Island at the Anna's Retreat Section of St. Thomas (see Figure 2-1 page 5). Most of the wells are used for public drinking water supply. The wells appear to be drilled into the Turpentine Run aquifer.

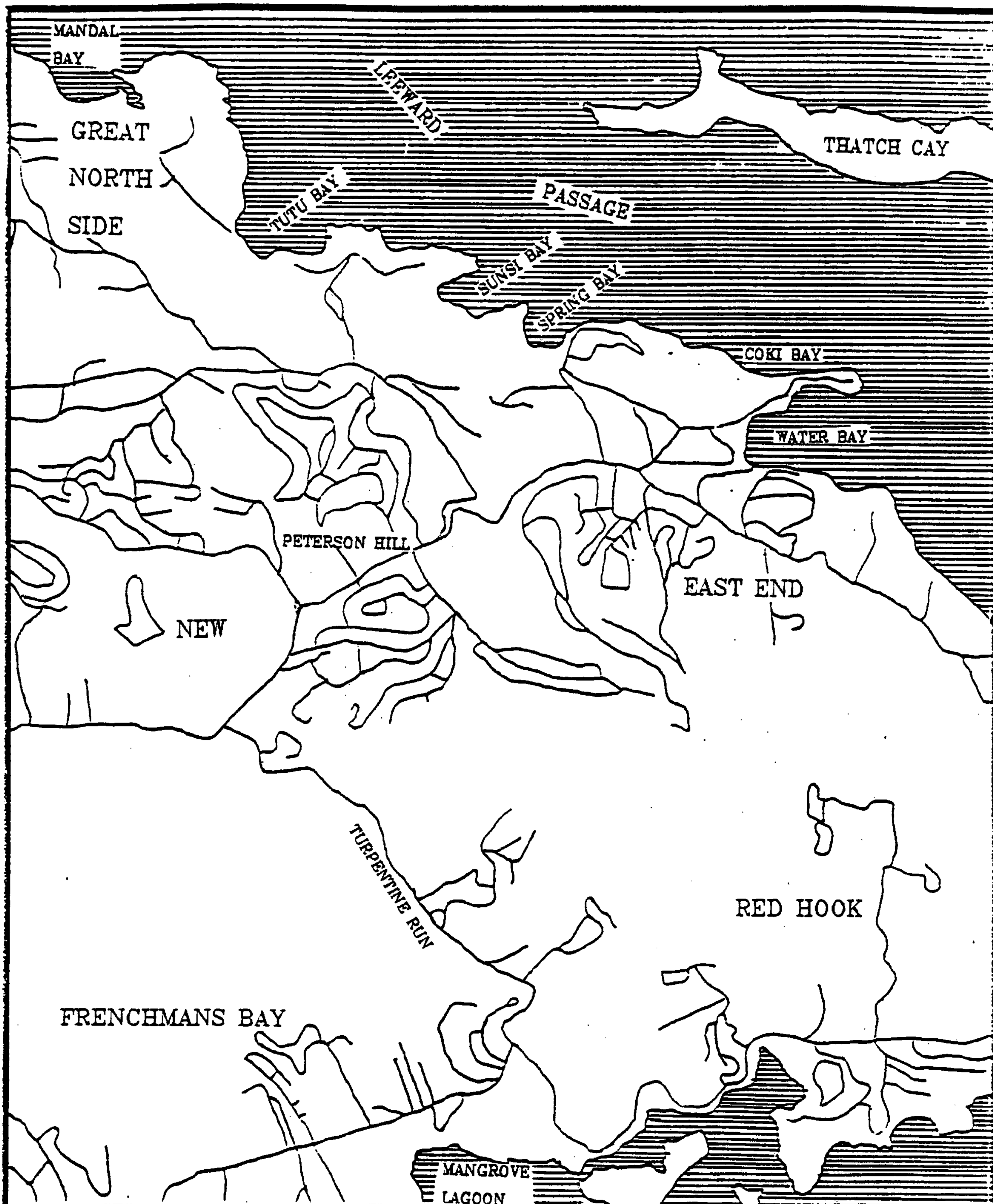
On, or about July 7, 1987, Mr. Eric Tillett, contacted the U.S. Virgin Islands (U.S.V.I.) Department of Planning and Natural Resources (DPNR) regarding an odor emanating from the raw well water on his property located at Anna's Retreat, St. Thomas, U.S.V.I.

On July 16, 1987, the USEPA received a request from the DPNR in St. Thomas, for sampling and analyses of several wells in Tutu. On July 21, the USEPA and its Technical Assistance Team (TAT) contractor, Roy F. Weston, Inc., mobilized to St. Thomas, to perform sampling on the drinking water wells suspected of being contaminated. These wells were also reported to have a strong, unpleasant odor and were found to be contaminated with hazardous substances.

The EPA and its Technical Assistance Team (TAT) in coordination with DPNR, initiated sampling of wells in the affected area in July 1987. The test results showed the presence of high concentrations of gasoline and chlorinated organic compounds. Seven wells: Elgin, Four Winds, Harthman, and Virgin Islands Housing Authority (VIHA) were closed down by order of DPNR due to high VOC concentrations.

Several of the wells in this area are major commercial well services used for public drinking water supply, therefore, the incident was classified as major, and the DPNR Commissioner requested the EPA to assume the role of Lead Agency. The well locations can be seen in Figure 2-2 page 6.

A Texaco station, located opposite the Tillet Well, is suspected as a possible source of contamination. A Petrotight test conducted on the underground storage tanks at this facility indicated leaks in two of



SPILL PREVENTION & EMERGENCY RESPONSE DIVISION

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EPA PM
CARLOS O'NEILL

TAT PM
R. HAFNER

FIGURE 2-1
SITE LOCATION MAP
TUTU ST. THOMAS
U.S. VIRGIN ISLAND

the three tanks. These failures may have contributed to the groundwater pollution problem, resulting in the contamination of nearby wells. Another suspected source of contamination is the Tutu Esso gas station. This facility stores waste oil in an underground storage tank. The facility has had problems in the past with leakage from their underground gasoline storage tank and is suspected of using solvents in the mechanic shop. At the time of inspection, the nature of the problem had not been determined.

EPA continued its efforts towards the identification of; affected wells in the area, customers which had received water from contaminated wells, and possible alternate water supplies and remedial action alternatives.

A testing program of wells located outside of the known area of contamination was conducted to evaluate those areas as possible alternate water supply sources.

Sampling of cisterns served by the contaminated wells was also performed. EPA directed the Emergency Response Cleanup Services contractor (ERCS) to; clean and disinfect the five (5) cisterns which had tested positive for PCE, modify the existing home plumbing, disconnect the contaminated wells, and dispose of the contaminated water. At EPA's direction, ERCS also contracted a local water hauler to deliver uncontaminated drinking water to the cisterns by tank truck. A well sampling program was established by the EPA to monitor the wells at the Tutu site for a one year period.

2.2 Topography and Geology[1]

"St. Thomas is the most northwest island of the U.S. Virgin Islands and the second largest. The island is approximately 14 miles long and 2 to 3 miles wide and has an area of 32 square miles.

The land surface is almost entirely sloping and extends seaward from a central ridge, 800 to 1,200 feet high, running the length of the island. The slopes, which commonly exceed 35 degrees, are dissected by numerous stream courses of steep gradient. The general appearance is a panorama of steep interstream spurs and rounded peaks. Flat inland is confined to the Charlotte Amalie area and a few small alluvial-filled embayments. The only variation in the general topography is in the upper valley of Turpentine Run in eastern St. Thomas. The valley has relatively gentle topography consisting of rolling hills in a basin surrounded by steep slopes and sharp ridges.

The Tutu Formation, the youngest rock exposed on St. Thomas is composed almost entirely of angular debris derived from the Louisenhoj Formation (an older volcanic formation) and minor limestone debris from thin limestone deposited contemporaneously with the Tutu Formation.

The rocks were subsequently tilted to form a northward-dipping homocline. Dips range from 15 to 90 degrees and average about 50 degrees. Locally the formations are overturned.

The permeable zones that these rocks once may have had after deposition have been destroyed by metamorphism or by deposition of minerals in pore spaces. Groundwater movement is now limited to openings along joints and fault zones. The homoclinal structure is cut by sets of faults trending N 45°W, N 55°E and north. Three well-defined joint sets parallel each of the major fault directions. The valleys of the island have similar trends and are apparently the result of selective erosion of rock weakened by faulting and jointing. Prime zones of groundwater availability, therefore, follow the valleys.

Small alluvial deposits ranging from Pleistocene to Holocene in age, lie in the valley of Turpentine Run in east-central St. Thomas and the larger coastal embayments.

The alluvium of Turpentine Run lies in a narrow band seldom more than 200 feet in width along the stream. Maximum thickness of the alluvium is about 40 feet. Most of the alluvium, which is composed of silt, fine sand, and clay and contains discontinuous beds of sand and gravel 2 to 3 feet thick; lies in the Mt. Zion-Tutu area of the upper basin and in the narrow valley from Mariendal to Mangrove Lagoon in the lower basin. The alluvium extends out under the lagoon near the mouth of Turpentine Run. Although composed predominately of fine-grained material, the alluvium readily infiltrates streamflow when the groundwater level is below the base of the stream. As such, the alluvium forms a readily rechargeable aquifer, although it is of small extent and yield.

Some coastal embayments headed by intermittant streams contain small deposits of alluvium similar to that of Turpentine Run. Maximum thickness of these deposits is estimated to be 50 feet, and their areal extent seldom is greater than a few acres (an exception being the Long Bay and Airport areas near Charlotte Amalie). Near the sea, the alluvium interfingers with calcareous sand and at times contains lenses of mangrove swamp deposits. Therefore, the deposits are of minor significance as sources of water".[1]

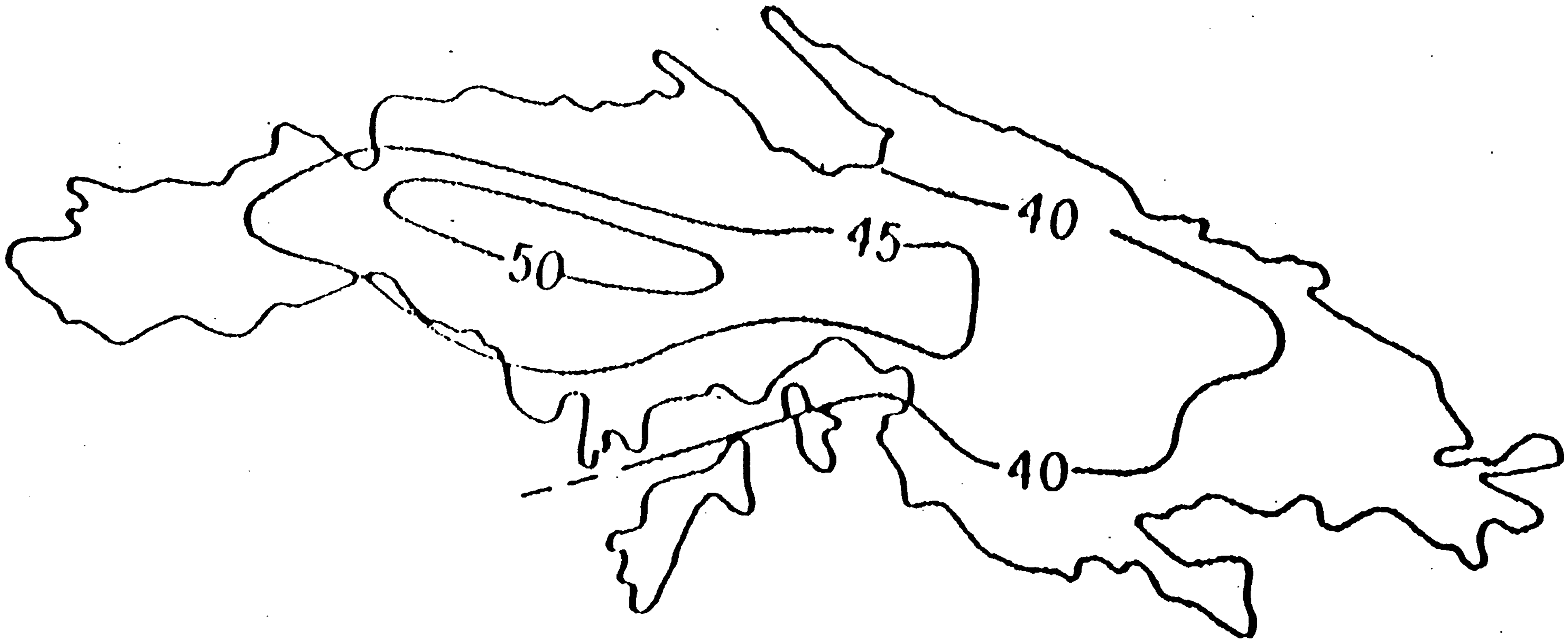
2.3 Rainfall[1]

"Rain is the only natural source of fresh water to replenish the water resources of the island. Rainfall is seasonal, with a rainy season in late summer and early fall and a secondary wet season usually in May. Nearly half the rain falls during August-November. Rains exceeding 1 inch in 24 hours come six or seven times a year. Four to 15 inches of rain falls in a 48-hour period about once every 2 years in large storms. These rains can occur in any month, but are more likely during the hurricane season (August-November). About 50 percent of the time annual rainfall is between 40 to 50 inches. Less than 10 percent of the time annual rainfall is under 35 inches, which usually means a major deficiency during the normal wet season and drought.

The cumulative departure from average and the 10-year running average of rainfall shows that at this time of writing (1967) the island may be entering a period of deficient rainfall. With the exception of a few years in the late 1940's and early 1950's, rainfall in the past 30 years has been below average. There has been a long-term decline of about 10 inches in annual rainfall since the peak of the surplus rainfall period in the early 1930's. The most severe droughts on record occcurred in 1964 and 1967, when only 27 and 24 inches of rain fell, respectively.

Areal distribution of long-term rainfall, is controlled by topography and the prevailing easterly to northeasterly winds. However, individual storms may or may not show the effects of orographic control or prevailing winds and the areal distribution of the storms can be very irregular".[1] See Figure 2-3, page 10, for average yearly rainfall.

ST. THOMAS: AVERAGE ANNUAL RAINFALL (IN INCHES)



From: A Survey of The Water Resources of
St. Thomas, Virgin Islands
D.G. Jordan and O.J. Cosner

WESTON SPILL PREVENTION & EMERGENCY RESPONSE DIVISION	EPA PM C. O'Neill	FIGURE 2-3
In association with ICF, Inc., Jacobs Engineering, Inc., & Tetra Tech, Inc.	TAT PM R. Hafner	St. Thomas, U.S.V.I. Average long term rainfall in inches.

2.4 Sampling Results

The Tutu well site has been sampled repeatedly over the last ten months and found to contain definite contamination. The initial assessment was conducted in July through September of 1987. Subsequent sampling and analysis has proceeded on a monthly basis. The initial assessment considered 24 wells and approximately 50 cisterns. Of these wells and cisterns; 24 wells and 5 cisterns were found to be contaminated. The 5 cisterns were cleaned and disinfected by the ERCS contractor. Subsequent monitoring has been considered for the 24 wells that showed some type of contamination.

Table 2-1 pg. 32, lists the wells included in the current sampling program. Tables 2-2 and 2-3 , pages 33-36, show the volatile organic analysis results of the contaminated wells and give the highest concentration of organic contamination found during the last six months.

The sampling, and most of the preliminary Photovac portable GC screening was conducted by the U.S. EPA Region II TAT. Certified drinking water laboratories have performed formal analyses to verify the photovac screening results and to cover the entire spectrum of possible hazardous contaminants.

Although, the concentration of these contaminants fluctuates monthly, it is noteworthy that the major contaminants have been 1,2-trans-dichloroethylene (DCE), trichloroethylene (TCE), tetrachloroethylene (PCE), toluene (TOL), benzene (BEN), tertbutyl methyl ether (TBME) and various metals. Their high concentration in four wells; Tillet, Harvey, Smith and Steele has been evident from the initial assessment. These wells show concentrations of volatile organics (VO) in excess of 1,000 ppb. The major and most consistent contaminant appears to be PCE. The Tillet well has also shown very high DCE and BEN contamination. Four other wells; Francois, Mathias, Four Winds, and Elgin; were confirmed to have >50 ppb VOCs.

The last confirmation analysis conducted during October 1987, included the entire Hazardous Substance List (HSL), (consisting of approximately 150 chemicals). At that time, significant levels of TBME up to 470 ppb, and methylene chloride up to 120,000 ppb were detected. Some samples have also shown traces of vinyl chloride, chloroform, 1,1,1-trichloroethane, bromodichloroethane, xylene, and ethylbenzene.

Finally, the HSL analysis also showed the presence of

EP toxic metals. The report showed the presence of eight distinct metals in some of the wells examined (See Table 2-4 page 37). Zinc was the most abundant element detected at a level of 460 ug/l. Selenium was also measured in two wells (VIHA #1 and Steele) at concentrations exceeding the PDWR limit of 10 ug/l.

In summary, the Tutu Wells Site monitoring has indicated persistent contamination in the well drinking water and the need for immediate remediation.

3.0 DRINKING WATER STANDARDS

3.1 EPA Regulations

The Safe Drinking Water Act of 1974, and amended in 1977, established primary and secondary drinking water standards. The primary standards were established to protect public health, while the secondary standards mainly addressed the physical characteristics of drinking water such as taste, odor, color and corrosivity (See Tables 3-1, 3-2, and 3-3, pages 38 and 39).

The Maximum Contaminant Level (MCL) and the Recommended Maximum Contaminant Level (RMCL) were developed by the EPA Office of Drinking Water to provide acceptable concentrations of specific organics and inorganics in public water supply systems. RMCL's are contaminant levels at which there are no known or anticipated adverse health effects to a human being. MCL's are enforceable health standards that are set as close to the RMCL's as feasible based upon practical considerations such as treatment technology, cost, and analytical methods and detection limits.

Removal Action Levels (OSWER Directive 9360.1-10)

Under the 1982 National Contingency Plan (NCP), removal actions were taken in response to "immediate and significant" threats to human health or the environment. The removal program used the 10-Day Health Advisory as the principal benchmark to identify those drinking water contamination incidents that posed the most acute threats to human health. The November 1985 NCP broadened removal authority by authorizing response in situations that present a "threat" to human health or the environment. Therefore, removal actions may now be taken in less urgent situations than under the 1982 NCP.

In response to this expansion of removal authority, the Office of Emergency and Remedial Response (OERR) is revising removal program action levels for contaminated drinking water sites. This guidance is contained in OSWER Directive 9360.1-10, "The Interim Final Guidance on Removal Action Levels at Contaminated Drinking Water Sites". This guidance was approved by the Director of OERR on October 6, 1987. This guidance expands the previous policy in a number of ways. First, the numeric action levels are now based on levels that are protective for a lifetime exposure rather than a 10-day exposure. Second, both carcinogenic and non-carcinogenic health effects are considered, Tables 3-4, Pages 40,41. Third, a reduction factor is used for volatiles to account for exposure due to inhalation. Finally, additional guidance is provided on the use of site-specific factors to trigger removal actions.

The action levels established in this guidance allow a site to qualify for removal response if either: 1) the numeric trigger is exceeded at the tap, or 2) site-specific factors otherwise indicate that a significant health threat exists. The guidance also discusses information sources on health threats from drinking water contamination, factors to consider in determining the extent of action, action levels vs. cleanup standards, prioritizing removal sites, and obtaining exemptions to the statutory limits for alternate water supply sites.

The appropriate calculation to determine action levels in accordance with each chemical category is listed below:

1. Non-volatile non-carcinogens -- Action level equals the Drinking Water Equivalent Level (DWEL).*

   $$*DWEL = \text{Reference Dose (RFD)} \times \frac{70\text{kg}}{2\ \text{liters/day}}$$

2. Volatile non-carcinogens -- Action level equals 50 percent of the DWEL.

3. Non-volatile carcinogens -- Action level is determined by comparing the DWEL to the 10^{-4} Lifetime Upperbound Cancer Risk Level, and choosing the lower of the two.

4. Volatile carcinogens -- Action level is determined by comparing 50 percent of the DWEL to the 10^{-4} Lifetime Upperbound Cancer Risk Level, and choosing the lower of the two.

The action level for methylene chloride, for example, is calculated as follows. Methylene chloride is a volatile and a potential human carcinogen (classified as a "B2" under EPA guidelines). The DWEL for methylene chloride equals 1750 ppb and the 10^{-4} Cancer Risk Level equals 48 ppb. The action level is determined by comparing 50 percent of the DWEL, or 875 ppb, to the 10^{-4} Cancer Risk Level, or 48 ppb, and choosing the lower of the two, which is 48 ppb.

The following is a summary of the maximum concentrations of the primary pollutants found in the contaminated wells and the statutory source for their designation as a hazardous substance under CERCLA.

Contaminant	Maximum Concentration Found (ppb)	Removal Action Level (ppb)	Statutory Sources For Designation As A Hazardous Substance Under CERCLA
Methylene Chloride	120,000	48	Clean Water Act Sec. 307(a)
Tetrachloroethylene	2,040	66	Clean Water Act Sec. 307(a)
Trichloroethylene (TCE)	711	128	Clean Water Act Sec. 311(b)(4)
Trans 1-2,Dichloroethylene (DCE)	620	175	Clean Water Act See. 307(a)
Benzene (BEN)	6,950	120	Clean Water Act Sec. 307(a)
Selenium	15	10	Clean Water Act Sec. 307(a)

3.2 USVI Department of Planning and Natural Resources (DPNR) Regulations

The Department of Planning and Natural Resources (DPNR) on September 1, 1987, adopted interim maximum permissible concentrations for volatile organic compounds in drinking water, 50 ppb for a single compound, or 100 ppb for total organic compounds.

4.0 LIST OF ALTERNATIVES

In order to provide a permanent water supply to the two three family homes and one apartment building housing twelve studio units, the EPA has considered the following alternatives:

1. No action.
2. Extend the existing water main.
3. Install new and deeper wells within the contamination area.
4. Install new wells beyond the area of contamination.
5. Install a whole house reverse osmosis unit at each location.
6. Construct a reverse osmosis central plant.

7. Construct a water treatment plant.

8. Increase the capacity of the cisterns.

9. Install individual activated carbon filters.

These alternatives will be briefly discussed in the next section.

5.0 DESCRIPTION OF ALTERNATIVES

5.1 No Action

This alternative is not acceptable within the regulatory and public health framework.

5.2 Extend Existing Water Main

This alternative would extend the existing 16 inch diameter (dia.) water main from the intersection of Routes 38 and 382 south to the intersection of Routes 32 and 38 by the Fort Mylner Shopping Center, and then east along Route 32. This extension will conform to the V.I. planned expansion of the present potable water system. The water main extension will include two branches, a 6" dia. main to the vicinity of Smith's residence, which will include a fire hydrant, and a 2" dia. pipe which will serve the Harvey residence and Steele apartment complex.

This alternative will provide safe potable water for the affected area. The water main will also serve a shopping center, various individual shops, and the local population which depend on ground water or water deliveries. In addition, the installation of hydrants provides fire protection in compliance with local fire codes.

The source of water would be the V.I. Water and Power Authority desalination plants in Crown Bay.

5.3 New and Deeper Wells Within The Contamination Area

The selection of a deeper well as an alternative would depend on the availability of an uncontaminated aquifer in the deeper zone. However, since the area consists primarily of fractured and jointed rock zones and water movement is limited to the openings along the cracks, the rate of contaminant migration into the aquifer is high. Also, because of the geology in St. Thomas, there is no deeper aquifer which would be shielded from the contamination. There is also a serious danger of salt water intrusion in this area, especially during long periods without recharge such as drought periods.

5.4 New Wells Located In Areas Beyond Contamination

Wells drilled in areas, 1, 3 and 5 (Figure 5-1 pg. 17 would presently be in non-contaminated zones. The yields obtained from these areas are relatively low and contain high concentrations of salt because of salt-water intrusion into the aquifer. Pumping of the new wells may also induce the contaminants to move toward the wells, thus defeating their purpose.

In addition, a piping distribution system would be necessary to deliver drinking water to the contaminated well area; thus this alternative does not provide a viable long term solution.

This alternative would also require easement land purchase for the delivery pipe to the apartment complex and two (2) homes affected by the contamination. In addition, purchase of the land for easement rights requires a minimum of six months.

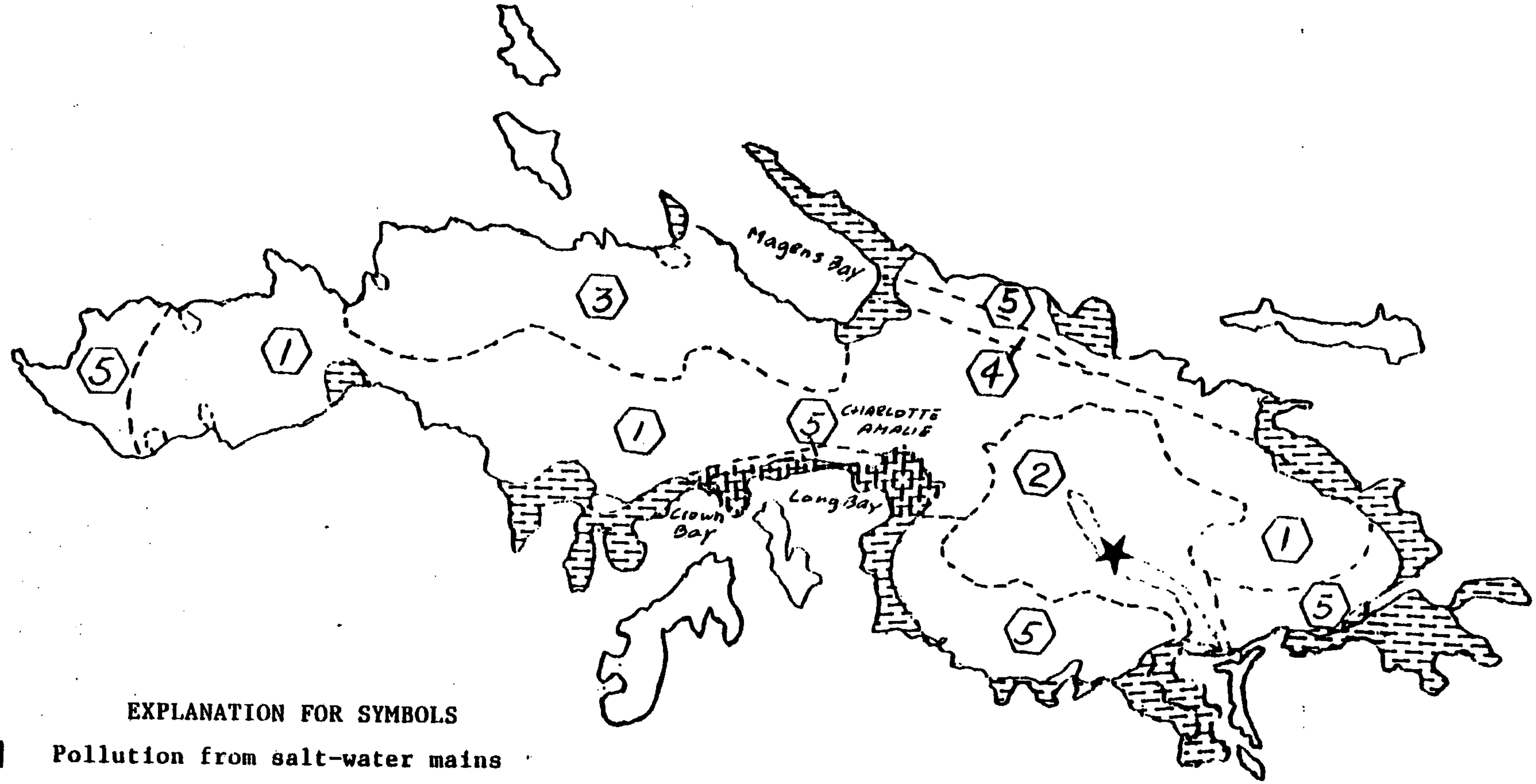
5.5 Whole House Reverse Osmosis

This alternative would provide a reverse osmosis (R.O.) system in each location for the treatment of contaminated well water. The R.O. process consists of a semi-permeable selective membrane which permits passage of certain components of a solution while restricting others.

The ideal R.O. system is used at a constant flow rate 24 hours/day. Constant flow rate operation provides more efficient removal of solute than variable flow rate opeations; and R.O. systems should operate at least 18 hours/day. The use of a R.O. unit for groundwater treatment will require hardness and alkalinity removal to minimize possible precipitation of insoluble chemicals within the unit.

There are two types of membrane materials available: cellulose membranes and thin film composite membranes. Cellulose membranes are not resistant to bacterial attack, the thin film composite membranes do not tolerate chlorine; as a result, depending on the membrane bacteria or chlorine must be removed prior to reaching the membranes. The capacity of the R.O. system will decrease with decreasing water temperature; therefore, a preheater may be needed in some cases.

The R.O. unit should monitor the flow inlet, water pressure, product water and waste water for efficient performance.



EXPLANATION FOR SYMBOLS

Pollution from salt-water mains

Encrochment by sea water

Boundary of area

Alluvial deposits

3 Areas

Tutu Well Area

WESTON SPILL PREVENTION & EMERGENCY RESPONSE DIVISION	EPA PM C. O'Neill	FIGURE 5-1
In Association with ICF Technology Inc., C.C. Johnson & Associates, Inc., Resource Applications, Inc., Geo/Resource Consultants, Inc., and Environmental Toxicology International, Inc.	TAT PM R. Hafner	St. Thomas, V. I. Groundwater Areas

This alternative would require an NPDES permit which would take at least one year to obtain.

5.6 Reverse Osmosis Central Plant

Many processes are used for desalination plants: distillation, electrodialysis, freezing, reverse osmosis and ion exchange.

The only process which could be used in this particular application is the R.O. because they are the smallest units available. The desalination plant would be situated by the ocean and would consist of a salt water intake, high pressure pumps to pump salt water into the plant, a pump station to pump the desalinated water to a storage tank, a force main, an elevated storage tank, and associated piping to supply water to each home.

One major drawback is the availability of land at a reasonable cost and the lengthy time required to purchase the land.

5.7 Water Treatment

This alternative would treat the combined well water of the apartment complex and the homes at a central location. The contaminated water would be brought into the treatment plant by a pipeline from each affected well, then treated, and pumped to an elevated, centrally located storage tank. The treated water will be redistributed by gravity to each apartment and home affected as needed. This alternative would require extensive surveying, piping, a pump station, an elevated distribution storage tank and land purchases. One major drawback is the availability of land at a reasonable cost and the lengthy time required to purchase the land.

5.8 Increase Capacity of Cisterns

Roof top catchments and cisterns provide a means for storing drinking water in the area. Rainfall in this area averages 40 in./year, of which 70% is recoverable. Assuming a catchment area of 500 square feet per family home and the rainfall occurring in a 4 month period, the required cistern size would be extremely large and impractical to store sufficient water for year round services. Also, storage of water over considerable periods of time results in bacterial growth with a resulting poor quality of water. Land for the construction of these larger catchments is not available.

5.9 Individual Activated Carbon Filters

These types of filters are excellent VOC removal medium. Carbon filters have been used and are presently being used to remove VOC's at NPL sites with great success. The systems, if properly designed, can last for up to 20 months or longer removing VOC's, however, carbon does not remove metals. Also, water samples have to be regularly collected after the units are installed to monitor the carbon treatment's effectiveness and the possibility of contaminant breakthrough.

The design is based on the carbon adsorption capabilities for a particular compound, contaminant concentration, contaminant loading capability, flow rate, column volume, and column longevity. Normally, two columns are mounted in series to prevent contamination in case of column breakthrough. Therefore, the use of activated carbon filters at Tutu is not recommended.

6.0 EVALUATION OF ALTERNATIVES

Each alternative will be evaluated based on the criteria listed in 6.1 to 6.8.

6.1 Design Parameters

a) Water Demand

The current water demand in St. Thomas is 38 gallons per capita per day (gpcd) or 152 gallons per day (gpd) per household of four persons. Any alternative will have to take into consideration the total population served by the wells which is 50 persons.

The Smith well serves three families, or 12 persons.

The water demand for the Smith Household will be 12 persons x 38 gcpd x $\frac{1 \text{ day}}{1440 \text{ min/day}}$ =

= 0.32 gallons per minute (gpm) = 456 gpd

The Steele well serves 28 persons.

The water demand for the Steele service will be 28 persons x 38 gcpd x $\frac{1 \text{ day}}{1440 \text{ min/day}}$ = 0.74 gpm

= 1064 gpd

The Harvey well serves 10 persons and their demand

$$10 \text{ persons} \times 38 \text{ gcpd} \times \frac{1 \text{ day}}{1440 \text{ min/day}} = 0.26 \text{ gpm}$$

= 380 gpd

The total demand for the wells affected by the groundwater contamination is 0.32 gpm + 0.74 gpm + 0.26 gpm = 1.32 gpm or 1,900 gallons per day.

b) Water Quality

The EPA is required to provide a safe, permanent and reliable potable water supply to the affected homes. Therefore, the water supplied to the homeowners must meet current drinking water quality standards.

Potable water shall be provided to the house cisterns in the risk area as a temporary measure until a reliable and safe alternate water supply is found and in operation.

6.1.1 General Preliminary Evaluation

The construction of new wells, either deeper or shallow, or wells removed from the area of contamination, does not appear to be a permanent alternative. These additional wells will increase the potential for salt water encroachment from the brackish water underlying, or adjacent to the fresh water. In addition, the cone of depression resulting from deeper wells may cause the contaminants to move deeper into the aquifer, thus contaminating a greater area of the aquifer.

Wells placed outside the area of contamination will induce contaminant movement into the clean area and could contaminate additional potable water wells.

Increasing cistern capacity is also not a permanent solution because of the rainfall fluctuation and its downward trend over the recently past years. The storage of water over a long period of time would also greatly increase the bacterial growth and would require individual water disinfection systems.

The reverse osmosis (R.O.) system, as mentioned in Sections 5.5 and 5.6, is used for desalination as well as for water purification. Some R.O. systems need to operate continuously to avoid biological membrane fouling and need very high levels of particulate removal (5 microns) to produce good quality water. The water purification plant will have to be specifically designed to remove all contaminants in the well water. Both the desalination and water purification units use a high pressure water feed; 800-1000 pound per square inch (psi) for the desalination plant, 200 psi for the water purification units.

Lately, new materials have been used for constructing the R.O. membranes especially in whole house systems. Culligan has new R.O. units whose membrane is a thin film composite which the manufacturers say lasts 4-7 years longer than cellulose acetate membranes whose life span is 3 to 4 years. The thin filter composite R.O. systems will have a rejection rate of about 80% for VOC's and have a removal rate of 99% on all VOC's. The rejection rate is the amount of water rejected as "brine" by the R.O., so that a system treating 1000 gpd and having a rejection rate of 50% assuming it is filtering VOC's will only produce 500 gallons of drinking water, the rest will be brine water.

The R.O. must have pretreatment, such as activated carbon filters and water softening. Whole house units for Smith and Harvey will cost $7,000 each including a 400 gallon storage tank. Mr. Steele's unit will cost $14,000 including a 1000 gallon storage tank.

The daily amount of feed water required from Mr. Steele's well will be at (50% rejection) $1100 \text{ gpd}/(1.0 - 0.50)^2 = 4,400$ gpd or 3.10 gpm. The membrane will produce 3,300 gpd of brine, which will be contaminated with VOCs and will have to be properly disposed of.

The activated carbon filters are good only for the adsorption and removal of volatile organic compounds but will not remove metals. In addition, the activated carbon filters must be monitored frequently for breakthrough of the hazardous substances and the carbon has to be replaced approximately every year depending on the contaminant load. The contaminated carbon must be disposed of as hazardous material, or regenerated if the particular state in which the carbon filters are in operation allows it. New York State requires that the carbon which fills the columns be virgin carbon, not regenerated carbon. Also, carbon loses approximately 10% of its volume by regeneration. Therefore, because of lack of metal adsorbtion in the carbon and the potential disposal problems, activated carbon will not be considered in this report.

The reverse osmosis system is a complicated one to install in the Virgin Islands due to the lack of technical services on the islands. A repair to the system would take considerable time and money and would probably leave the consumers without drinking water for several months while service personnel arrived from the mainland.

The R.O. unit would require the installation of a water main. The water main would consist of 2300 linear feet (L.F.) of 12 inch ductile iron pipe (DIP) and 950 L.F. of 6 inch DIP; 1000 L.F. of 2 inch plastic pipe will supply the Steele and Harvey residences. Virgin Islands Fire Department regulations require a minimum pipe size of 6 inches, a maximum distance of 500 feet between fire hydrants, and a pipe to be able to supply upon demand 1,000 gpm water at 50 pounds per square inch (psi) delivery pressure.

6.2 Environmental Impact

All alternatives will have adverse environmental effects except for the extension of the water main. The wells will produce salt water intrusion and/or spread the area of contamination. Reverse osmosis plants produce brine which will be highly contaminated not only with metals, but with VOC's. The disposal of the brine water will significantly increase the project operation cost for homeowners, as it will have to be disposed of as highly hazardous waste. The activated carbon units will produce about three 55-gallon drums of highly contaminated aqueous slurry. The water treatment plant will also produce contaminated aqueous slurry from the chemicals introduced to aid in the settling process.

6.3 Operation and Maintenance

The operation and maintenance efforts for the package water treatment and the R.O. plants would be extensive as compared with any of the other alternatives. Qualified personnel would be required to maintain and operate the plants. In addition, both water treatment and an R.O. central plant system would require a distribution reservoir, piping and a pump station to transfer water to and from the reservoir. The water treatment plant will require chemicals for treatment and disposal of the sludge. The desalination plant will require an intake structure. The maintenance required by the water main extension will be minimal because water mains generally are trouble-free.

6.4 Reliability

Each alternative must provide safe drinking water without extensive long term maintenance.

New deeper wells or wells located beyond the contamination zone would not provide a reliable long term solution because of the possibilities of salt-water encroachment and a higher rate of contaminant migration.

Desalination plants and water treatment plants are generally reliable; however, the equipment required is subject to breakdowns. The reverse osmosis, desalination and water treatment plants will require a skilled person working a minimum of one day per week to check the operation, dispense chemicals, make adjustments, and perform possible repairs for the continued production of potable water.

The extension of the existing water mains to the contaminated area would provide the most reliable source of safe drinking water to the residents.

6.5 Site Constraints

There are no site constraints for any of the alternatives proposed. All alternatives could be reasonably installed without any unusual site problems except for the alternatives requiring elevated reservoirs, on-site treatment and desalination.

6.6 Public Acceptance

The proposed alternatives do not present any objectionable problems which would be unacceptable to the public. The water main extension is probably the alternative that the public would most readily accept because water supplied from a main source is generally considered safer because of the daily monitoring required by personnel who are constantly in attendance.

6.7 Summary of Cost Estimate For Alternatives (See Appendix, Page 44 for detailed estimates for each alternative)

1.	NO ACTION	$ 0.0
2.	EXTENTION OF THE EXISTING WATER MAIN. (See Selected Alternative, Page 28 for detailed estimate).	$ 647,000
3.	INSTALL DEEPER WELLS WITHIN THE CONTAMINATED AREA	$ 375,000
4.	INSTALL A NEW WELL BEYOND THE AREA OF CONTAMINATION	$ 545,000
5.	WHOLE HOUSE REVERSE OSMOSIS	$38,000,000
6.	CONSTRUCT A WATER TREATMENT PLANT	$ 400,000
7.	CONSTRUCT A REVERSE OSMOSIS CENTRAL PLANT	$ 375,000
8.	INCREASE CAPACITY OF CISTERNS	$ 360,000
9.	ACTIVATED CARBON FILTERS	$ 100,000

6.8 Implementation Time

The implementation time would be the longest for alternatives requiring the construction of a water treatment plant, especially if it is constructed in an area where no surveys have been made. Therefore, it can be assumed that for the desalination and package water treatment plant it would take a minimum of six months to a year to study the pipe routing, survey, possible land purchases, and drawings. In addition, permits would be required and may be difficult to procure as any water main installation will infringe on the utility rights (WAPA). Of all the alternatives proposed, the water main extension would be the quickest to construct. The survey and drawings are already completed and construction is ready to begin. Based on the estimate, the water main could be in place in five months.

7.0 ALTERNATIVES COMPARISON AND SELECTION

7.1 Alternative Comparison Summary

The various alternatives discussed in Sections 5 and 6 are summarized in Table 7-1, page 42. The different alternatives were rated for public acceptibility, reliability, maintenance, long term safe drinking water, implementation time, and cost. Every alternative was given a numerical rating from 1 to 5 for each criteria.

7.2 Selection

The alternative selected is the extension of the existing water mains. This alternative will provide the residents with safe drinking water at a reasonable cost, maintenance free, and over a long period of time.

The comparison chart, Table 7-1, page 42, shows the acceptable and unacceptable features of each alternative and the reasoning for making the selection.

At the right end of the chart the ratings for each alternative are totalled, the lower the total number the more acceptable is the alternative.

Thus, the water main extension is the preferred alternative.

This alternative can be implemented in the quickest time period and will, therefore, reduce the cost for bottled water delivery.

8.0 SELECTED ALTERNATIVE

8.1 Description of the Selected Alternative

The apartment complex and homes with contaminated drinking water wells will be connected to the proposed water main extension along Routes 38 and 32 at EPA expense. Installation of this water main will provide a safe and reliable drinking water supply to the inhabitants of the apartment complex and homes and prevent health risks associated with exposure to contaminated groundwater.

The selected alternative will extend the existing 16 inch DIP water line south along Route 38 to the Fort Mylner Shopping Center and then east along Route 32 (see Figure 8-1, pg 27). The pipe lengths to be installed are as follows: 3,170 L.F. of 12 inch dia. pipe, 950 L.F. of 6 inch dia. pipe, and 1,000 L.F. of 2 inch dia. pipe. The proposed alternative will cover part of the 1990 plan referred to in the "Water Distribution System Master Plan for St. Thomas, U.S. Virgin Islands" prepared for the Department of Conservation and Cultural Affairs (DCCA) in December 1983 by CH2M Hill, Gainesville, Florida[4]. The proposed alternative will include a 12 inch diameter main with a 2 inch and a 6 inch diameter lateral. There are three proposed hydrants along the water main extension, two in the 12 inch dia. pipe and one in the 6 inch dia. lateral. Prior to the connection to the existing main, a thorough investigation of the last 1,700 feet of the existing main would be necessary. This part of the main has never been used. The pipe and the valves should be checked and parts may need to be replaced before the system could be operational. In addition, the 1,700 feet of water main would have to be pressure tested and disinfected. This installation will provide drinking water connections for the persons using the contaminated wells for drinking water.

8.2 Detailed Costs

The detailed costs for the selected alternative were based on average daily production rates for the various tasks taken from the means construction cost data book.

The estimate provides for funding to the engineering company for the survey, profile drawings, piping design for the Route 32 Circle, checking of existing pipe drawings and specifications.

The costs assume that the mains (6" dia. and 12" dia. pipes) will be ductile iron pipe (DIP), cement lined, class 250; that polyvinyl chloride (PVC) 2" dia. pipe will be installed from the water main up to the house class 250; that polyvinyl chloride (PVC) 2" dia. pipe will be installed from the water main up to the house property line, Steele and Harvey, and house connections will be made as per current WAPA specifications and will include water meters. It is further assumed that the PVC pipe will be installed concurrently with the water main installation. The checking, disinfection and possible repairs to the existing, but unused, 16" dia. main will take 10 working days, connection of the new water main to the existing 16" dia. DIP main will take 5 working days and the three house connections, 2 working days. Pipe fittings, disinfection, trenching, filling, compaction and road restoration are included in the installation costs per L.F. of pipe.

It is assumed that the ERCS response manager (R.M.) will be in St. Thomas full time for the first three weeks; the first two weeks procuring permits, drawing, and other pertinent information; and the first week of actual construction, then he will be present three days every three weeks and the entire last week of the project to ensure the total completeness of the project. TAT will also be on St. Thomas during the first two weeks of site preparation and during the entire project duration. The project will require two TAT members who will replace each other every three weeks.

Project costs for the selected alternative are summarized on the pages 28 and 29.

EXTENSION OF THE EXISTING WATER MAINS

PROJECT COST USING A LOCAL CONTRACTOR WITH MINIMAL ERCS SUPERVISION

The following costs are based on a 12 hour day, 5 days p (60 hours/week). Length of pipe installed per 12 hour d linear feet (L.F.) per day of 12" dia. DIP and 106 L.F. of 6" dia. DIP.

I. EXTRAMURAL COSTS

A. ERCS Contractor Costs

a) Engineering

Survey, Profile drawings, Specifications and construction inspections $

b) Labor and Material

Mobilization and Demobilization $
3170 L.F. 12" dia. DIP @ $70 L.F.
950 L.F. 6" dia. DIP @ $50 L.F.
1000 L.F. 2" dia. PVCP @ $5.00 L.F.
Rock Excavation 5 (estimated) @ $275.00
2 hydrants @ $2,800 each
3 each valves @ $500 each
1 each air relief valve @ $3,500 each
1 each Check existing 16" dia. DIP and repair
1 each valve box 12x12x12 $7,300
1 each Connection to existing 16" DIP
3 each House connections (3) $500 each

SUBTOTAL $ 3

c) ERCS Personnel

Response Manager (Level 3)
29 days at 12 hour days x $55/hr = $ 1
29 days per diem at $180/day =
Rental car 29 days at $55/day =
Five (5) airfare Newark-St. Thomas at $500/each
Field Clerk/Typist (NJ) 120 hr. x $29/hr. =
Equipment
Office Trailer, 1,300/mo. x 3 mo. =

SUBTOTAL $ 37

Subtotal of all Mitigation Costs (b + c) $ 389
* Contingency 25% 97

Total Mitigation Costs $ 486,

Rounded to nearest thousand $ 487,

*Modified Contingency percentage from 15% to 25% due to unknown labor costs, in V.I.

B. TAT Costs

80 days x 12 hours x $71/hr	$	68,160
Three (3) airfare Newark - St. Thomas at $500/each		1,500
Five (5) airfare Puerto Rico - St. Thomas at $80/each	$	400
Office support 75 hours x $55/hr	$	4,125
80 days per diem x 180/day	$	14,400
SUBTOTAL	$	88,585
Contingency (15%)	$	13,288
TOTAL	$	101,873
Rounded to nearest thousand	$	102,000

II. Intramural Costs

960 hrs (Region) + 960 x .10 (HTQ) x $30/hr.	$	31,680
80 days per diem x $180/day	$	14,400
Rental car 80 days x $45/day	$	3,600
Eight airfare Puerto Rico - St. Thomas at $80/each	$	640
SUBTOTAL	$	50,320
Contingency (15%)	$	7,548
TOTAL	$	57,868
Rounded to Nearest Thousand	$	58,000
Total TAT and Intramural Costs	$	160,000
Total Extramural	$	487,000
TOTAL REMOVAL PROJECT CEILING	$	647,000

8.3 Implementation Schedule

The implementation schedule is presented in Figure 8-2, page 31. The figure shows a total of twenty one weeks of scheduled tasks. The main items in the schedule are: procurement of materials, eight (8) weeks, check, repair, and disinfect existing water main, two week, 12 inch water main connection, one week, new water main installation 12 inch and 6 inch and road resurfacing, nine and a half weeks, and house connections, one half week. The installation of the new 2 inch water main to serve the Harvey and Steele residences and backfilling will be done concurrently with the 12 inch main. Survey, drawings and specifications preparations and approval, construction permits will be done during the last five (5) of the initial eight weeks alloted for the procurement of materials. It is assumed that TAT will be present in St. Thomas to assist in acquiring the necessary permits approvals and design drawing inspection during the two weeks prior to construction.

Time To Complete The Project:

$$\frac{3170\ \text{L.F.}}{88\ \text{L.F./Day}} + \frac{950\ \text{L.F.}}{106\ \text{L.F./Day}} + 17\ \text{Days} = 62.4\ \text{Days}$$

Say 65 Working Days = 13 Weeks; TAT = 13 + 2 = 15 Weeks

Figure 8-2
PROPOSED WORK SCHEDULE
FOR ERCS CONTRACTOR WORK
(12 HRS/DAY 5 DAYS/WEEK)

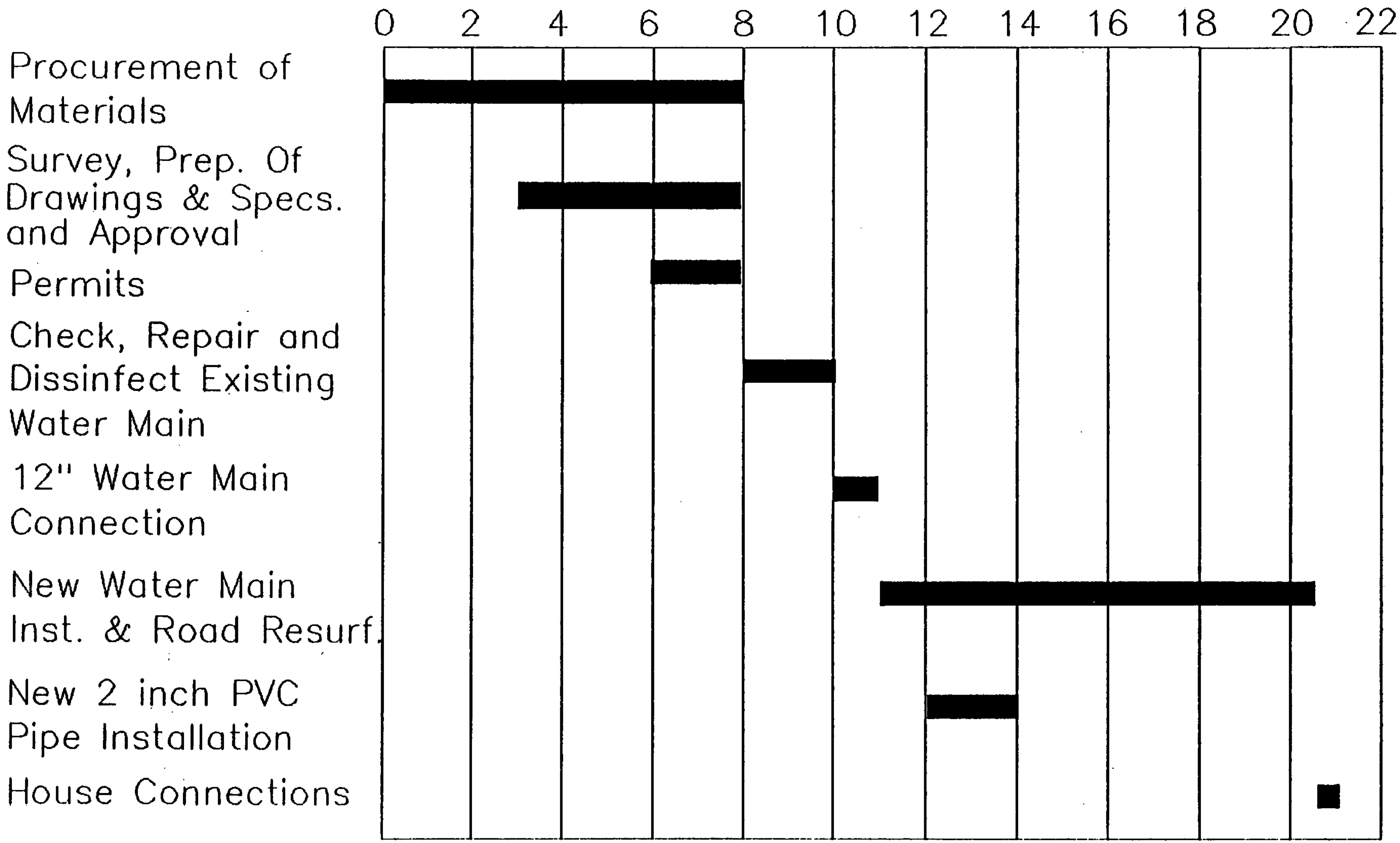


TABLE 2-2

HIGHEST AMOUNT OF CONTAMINATION
DETECTED ON PHOTOVAC FROM
SEPTEMBER 1987 TO JANUARY 1988

CONTAMINANT (PPB)

WELL	BEN	TOL	PCE	TCE	DCE
EGLIN #2	ND	< 5	40	10	< 5
EGLIN #3	ND	1	105	< 20	< 5
SMITH	ND	ND	>25	7	< 1
TILLET	ND	250	475	75	< 10
4 WINDS	ND	2	125	< 15	5
STEELE	ND	ND	575	9	< 5
HARVEY	ND	ND	500-2500	15	< 1
DEMETRIS	ND	ND	ND	ND	ND
DEDE	ND	ND	ND	ND	ND
DEVCON #1	ND	ND	ND	ND	ND
DEVCON #3	ND	ND	ND	ND	ND
VIHA #1	ND	ND	14	< 1	0
VIHA #3	ND	ND	ND	<<1	ND
EGLIN #3	ND	1	60	<10	<5
DENCH	ND	ND	ND	ND	ND
RAMSEY	ND	ND	8	<<1	ND
H. CRUSHE	ND	ND	14	1	<1
H. BAKERY	ND	ND	1	<1	ND
H. ESTATE	ND	ND	ND	ND	ND
LEONARD	ND	ND	ND	ND	ND
FRANCOIS	ND	1	180	25	5
RODRIGUEZ	ND	ND	ND	ND	ND

TABLE 2-2 (cont'd)

HIGHEST AMOUNT OF CONTAMINATION
DETECTED ON PHOTOVAC FROM
SEPTEMBER 1987 TO JANUARY 1988

CONTAMINANT (PPB)

WELL	BEN	TOL	PCE	TCE	DCE
BRYAN	ND	ND	ND	ND	ND
MATHAIS	ND	ND	118	3	<1
RAL	120	ND	66	128	175

LEGEND:

< LESS THAN
> GREATER THAN
BEN BENZENE
TOL TOLUENE
PCE PERCHLOROETHYLENE
TCE TRICHLOROETHYLENE
DCE 1,1-DICHLOROETHYLENE
ND NOT DETECTED

TABLE 2-3

HIGHEST AMOUNT OF CONTAMINATION
CONFIRMED BY GC/MS FROM
SEPTEMBER 1987 TO JANUARY 1988

CONTAMINANT (PPB)

WELL	BEN	TOL	PCE	TCE	DCE	TBME*
DENCH	0	0	0	0	1	
RAMSEY	5	30	154	46	3	0
H.CRUSHER	5	38	130	46	12	0
H. BAKERY	<1	633	3	5	<1	
H. ESTATE	<1	1	3	0	0	
LEONARD	0	1	3	0	0	0
FRANCOIS	0	1	>1000	180	140	180
DEMETRIS	<1	3	4	2	<1	
DEDE	<1	0	0	< 1	1	
DEVCON #1	0	0	0	< 1	< 1	
DEVCON #3	0	0	0	0	< 1	
EGLIN #1	2	5	450	300	63	
EGLIN #2	3	6	760	404	74	
EGLIN #3	0	1	500	268	66	
SMITH	1	1	>1000	130	81	34
4 WINDS	7	6	450	100	213	470
STEELE	0	0	>1000	160	61	37
HARVEY **	0	1	760	350	56	
RODRIGUEZ	0	0	1	<1	<1	
BRYAN	0	0	0	<1	0	
MATHAIS	0	1	6348	<55	9	
VIHA #1	15	6	36	9	12	

TABLE 2-3 (cont'd)

HIGHEST AMOUNT OF CONTAMINATION
CONFIRMED BY GC/MS FROM
SEPTEMBER 1987 TO JANUARY 1988

CONTAMINANT (PPB)

WELL	BEN	TOL	PCE	TCE	DCE	TBME*
VIHA #3	<1	3	2	1	7	
TILLET	6950	492	2040	711	620	470
RAL	120		66	128	175	

* FROM 10/87 HSL ANALYSIS BY EPA

** SHOWED A CONCENTRATION OF 120,000 PPB METHYLENE CHLORIDE IN THE 10/87 HSL

LEGEND

BEN BENZENE
TOL TOLUENE
PCE PERCHLOROETHYLENE
TCE TRICHLOROETHYLENE
DCE 1,1-DICHLOROETHYLENE
RAL EPA REMOVAL ACTION LEVEL

TABLE 2-4
METALS AND CYANIDE CONCENTRATIONS
AT TUTU WELL SITE DURING
HSL OCTOBER 1987 SAMPLING

Contaminant (ug/l)

Well	Cyanide (mg/l)	Antimony	Arsenic	Chromium	Copper	Selenium	Thallium	Zinc
Field Blank	0.016M							10
Bryan								30
Tillet	0.051M			8M	10M			10
Four Winds				6M	5M			51
Elgin #3				6M	5M		3M	98
Elgin #2					8M			200
Elgin #1	0.058				5M			82
Francois	0.018M			9M				108
VI Housing#1	0.023				10M	13*		30
VI Housing#3	0.019M				22M	3M		30
Harthman Estate						4M		20
Demitri					20J	3M		40
Rodriguez					5M			30
Ramsey	0.018	2M						10
Steele		3M		20M	20M	15*		20
Harvey				10M	8M			340
Mathias					9M	5.6		10
Smith					7M	3M		460
Devcon#1								10
Devcon#2				10M		7.1		20
A. Leonard						8.5		10
H. Crusher			15					10
Dede					10M			30
Dench		4M			10M		12*	68
H. Bakery		1M						20
Drinking Water Standard			50 ug/l		1	10 ug/l		500 ug/l
Guidelines	220,000				1,400,000			

M = Detected but not quantified J = Estimated * = Significant value

Note: In lab report all units are ug/l except cyanide which is reported as mg/l

TABLE 3-1 PRIMARY DRINKING WATER REGULATIONS FOR INORGANICS (40 CFR, PART 141)

Contaminant	[(mg/l)]
Arsenic	0.05
Barium	1
Cadmium	0.010
Chromium	0.05
Fluoride	1.4-2.4
Lead	0.05
Mercury	0.002
Nitrate (as N)	10
Selenium	0.01
Silver	0.05

TABLE 3-2 PRIMARY DRINKING WATER REGULATIONS FOR ORGANICS (40 CFR, PART 141)

Contaminant	Maximum Level [mg/l]
(a) Pesticides	
Endrin	0.0002
Lindane	0.004
Methoxychlor	0.1
Toxaphene	0.0005
(b) Chlorophenoxys	
2,4-D, (2,4-Dichlorophenoxyacetic acid)	0.1
2,4,5-TP (Silvex) (2,4,5,-trichloro-phenoxypropionic acid)	0.01
(c) Total trihalomethanes	0.10

TABLE 3-3 NATIONAL SECONDARY DRINKING WATER STANDARDS (40 CFR, PART 143)

Contaminant	Maximum Level
Chloride	250 mg/l
Color	15 color units
Copper	1 mg/l
Corrosivity	Non-corrosive
Foaming Agents	0.5 mg/l
Iron	0.3 mg/l
Manganese	0.05 mg/l
Odor	Threshold Odor Number 3
pH	6.5 - 8.5
Sulfate	250 mg/l
TDS	500 mg/l
Zinc	5 mg/l

TABLE 3-4
1987 WATER QUALITY CRITERIA BASED ON HEALTH FOR NON-CARCINOGENIC (THRESHOLD) POLLUTANTS

Substance	Criterion [a] (ug/l)	Comment
Acenaphthalene	20	Organoleptic properties
Acrolein	320	
Antimony	145	
Cadmium	10	
Chlorobenzene	20	
bis-(2-chloroisopropyl)ether	34.7	
Chlorophenols (all mono isomers)	0.1	Organoleptic properties
Chromium (VI)	50	
Chromium (III)	170,000	
Copper	1,000	
Cyanide	200	
Dibutylphthalate	34,000	
Dichlorobenzenes (all isomers)	400	
2,3-dichlorophenol	0.04	Organoleptic properties
2,4-dichlorophenol	3,090	
	0.3	Organoleptic properties
2,5-dichlorophenol	0.5	Organoleptic properties
2,6-dichlorophenol	0.2	Organoleptic properties
3,4-dichlorophenol	0.3	Organoleptic properties
1,3-Dichloropropenes	87	
Di-2-ethylhexyl phthalate	15,000	
Diethylphthalate	350,000	
2,4-dimethyl phenol	400	Organoleptic properties
Dimethyl phthalate	313,000	
2,4-dinitro-o-cresol	13.4	
2,4-Dinitrophenol	70	
Endosulfan	74	
Endrin	1	
Ethylbenzene	1,400	
Fluoranthene	42	
Hexachlorocyclopentadiene	1.0	Organoleptic properties
Isophorone	5,200	
Lead	50	
Mercury	0.144	
2-methyl-4-chlorophenol	1,800	Organoleptic properties
3-methyl-4-chlorophenol	3,000	Organoleptic properties
3-methyl-6-chlorophenol	20	
Nickel	13.4	
Nitrobenzene	30	Organoleptic properties

TABLE 3-4
1987 WATER QUALITY CRITERIA BASED ON HEALTH FOR NON-CARCINOGENIC (THRESHOLD) POLLUTANTS
(Continued)

Substance	Criterion [a] (ug/l)	Comment
Pentachlorophenol	30	Organoleptic properties
Phenol	3,500	Organoleptic properties
Selenium	10	
Silver	50	
2,3,4,6-tetrachlorophenol	1.0	Organoleptic properties
Thallium	13	
Toluene	14,300	
1,1,1-trichloroethane	18,400	
2,4,5-trichlorophenol	1.0	Organoleptic properties
Zinc	5,000	Organoleptic properties

[a] Unless otherwise indicated, the criterion is based on ingestion of water and contaminated organisms.

Table 7-1
Alternative Comparison Chart

Alternative	Public Acceptibility	Reliability	Maintenance	Long Term Safe Drinking Water	Implement-ation Time	Cost	Total
No Action	5	*	*	*	*	*	*
New Wells	3	1	1	4	5	4	18
Deeper Wells	3	1	1	4	5	3	17
Reverse Osmosis	3	5	5	3	5	5	26
R.O. Central Plant	3	5	5	3	5	3	21
Water Treatment Plant	3	3	4	3	5	3	21
Increase Cistern Volume	4	4	1	5	2	1	17
New Water Main Extension	1	1	1	1	3	4	11
Activated Carbon	2	2	4	4	2	1	15

<u>REFERENCES</u>

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3. AWWA, <u>Water Quality and Treatment</u>, Third Edition, McGraw-Hill, New York, 1971, p. 587-622.

4. CH2MHill, Water Distribution Master Plan for St. Thomas, U.S. Virgin Islands, Vol. 1, December, 1983. Prepared for the Department of Public Works, Government of the Virgin Islands.

LIST OF APPENDICES

APPENDIX A

APPENDIX B

U.S. ENVIRONMENTAL PROTECTION AGENCY

POLLUTION REPORT

DATE: July 14, 1987

Region II
Response and Prevention Branch
Edison, New Jersey 08837

(201) 548-8730 - Commercial and FTS
24 Hour Emergency

TO: C. Daggett, EPA
S. Luftig, EPA
F. Rubel, EPA
J. Marshall, EPA
ERD Washington, (E-Mail)
USCG 7th District (mep)
G. Zachos, EPA
B. Sprague, EPA
P. Gelabert, EPA
T. Taccone, EPA
A. Smith, EPA
J. Lee, DOI
TAT

POLREP NO.:	One (1)
INCIDENT NAME:	Tutu Well Site
POLLUTANT:	Gasoline
CLASSIFICATION:	Potential Major
SOURCE:	Underground gasoline storage tank
LOCATION:	Wheymouth-Rhymer Highway, Tutu St. Thomas, Virgin Islands
AMOUNT:	Unknown, greater than 100 gallons
WATER BODY:	Caribbean Sea, Atlantic Ocean and Groundwater

1. SITUATION:

A. On July 16, 1987, the U.S. EPA received a request from the Department of Planning and Natural Resources (DPNR) [(formally known as the Department of Conservation and Cultural Affairs (DCCA)] St. Thomad, Virgin Island (VI) for analytical support in the sampling of several wells which were reported to exhibit a strong unpleasant odor. The wells, several of which are major well services used for distribution of the public drinking water supply, are located on the eastern end of the island in the Tutu section of Annas Retreat St. Thomas, VI.

B. The sources of contamination is as of the present unknown. A suspected source is a local Texaco Station which had exhibited poor storage practices in the past. A petrotight test was conducted at this service station in the early part of July resulting in the failure of two of three tanks. Further information on the extent of tank leakage has not been forwarded to the DPNR or the U.S. EPA UST Program Director.

2. ACTION TAKEN:

A. On July 21, 1987, U.S. EPA and their Technical Assistance Team contractor Roy F. Weston, Inc. responded to the VI to assist the DPNR in well sampling and provide analytical services to determine the extent of contamination.

B. On July 22, 1987, samples from six wells were collected and sent to a laboratory in New Jersey for volatile organic analysis and total organic carbon content.

C. No product was discovered in the wells, therefore, no fingerprinting analysis could be performed by the USCG Coil Laboratory.

D. On Thursday, July 23, 1987, DPNR held a meeting with Texaco, to discuss an implementation schedule and work plan for the Texaco Station.

Cause Codes: (M) - Tank failure

(G) - Lack of indicator/detection equipment

3. FUTURE PLANS AND RECOMMENDATIONS:

A. U.S. EPA will forward sample results to DPNR as soon as they are received.

B. DPNR will formally notify Texaco in writing as to the proper cleanup practices to initiate at this site to ensure compliance with VI and Federal regulations.

FINAL POLREP ____ (TAT) FURTHER POLREPS FORTHCOMING X SUBMITTED BY: Paula A. Cammarata

Paula Cammarata, OSC
Response and Prevention Branch

DATE RELEASED: 7-31-87

U.S. ENVIRONMENTAL PROTECTION AGENCY

POLLUTION REPORT

DATE: July 31, 1987

Region II
Response and Preventive Branch
Edison, New Jersey 08837

(201) 548-8730 - Commercial & FTS
24 Hour Emergency

TO: C. Daggett, EPA
S. Luftig, EPA
R. Salkie, EPA
F. Rubel, EPA
P. Gelabert, EPA
J. Marshall, EPA
W. Sawyer, EPA
ERD Washington
(E-Mail)
J. Czapor
USCG 7th District (mep)
G. Zachos, EPA
B. Sprague, EPA
T. Taccone, EPA
A. Smith, DPNR
J. Lee, DOI
J. Zark, USGS
TAT

POLREP NO.	Two (2)
INCIDENT/SITE NO.:	Tutu Well Site
POLLUTANT:	Gasoline , Solvents, Voltile Organics
CLASSIFICATION:	Potential Major
SOURCE:	Underground Gasoline Storage Tank
LOCATION:	Wheymouth-Rhymer Highway, Tutu St. Thomas, Virgin Islands
AMOUNT:	Unknown, greater than 100 gallons
WATER BODY:	Caribbean Sea, Atlantic Ocean and Groundwater

1. SITUATION:

A. See previous polrep.

2. ACTION TAKEN:

Monday, July 27, 1987

A. USEPA arrived on St. Thomas and met with Commissioner Smith of the Department of Planning and Natural Resources (DPNR) to coordinate the weeks activities and to exchange information on the status of work accomplished from the prior week.

B. Commissioner Smith of DPNR issued an order to Texaco Caribbean, Inc. to cease tank removal activity at the Tutu Texaco Service Station located at Anna's Retreat. This order refrained the removal of tanks, soil, and/or any activity which would disturb the immediate area.

Tuesday, July 28, 1987

C. USEPA received the preliminary results from the sampling conducted on July 22, 1987.

D. USEPA met with Commissioner Smith and DPNR staff to discuss results of the sampling and to establish the next phase of activities to be accommplished.

Wednesday, July 29, 1987

E. At 1000 hours, USEPA and DPNR met with Texaco to discuss the necessary sequence of events with must be met prior to initiating excavation at the Tutu Texaco Service Station.

F. USEPA met with Commissioner Smith and DPNR staff to commence the development of the modified order to Texaco to include a Safety Plan, Sampling Plan, Action Levels and the assignment of an Operations Coordinator to work with EPA and DPNR to assure all local and federal regulations are complied with.

G. At 1000 hours, a hearing was held at the DPNR office. Representatives from DPNR, USEPA,Texaco and Tutu Water Supply were in attendance. The hearing was held to ensure that Texaco was in full understanding of the order issued on July 27, 1987 and its restrictions. Texaco stated during the hearing they would fully comply with local and federal regulations and would cooperate with DPNR. The Commissioner announced a modified order would be forthcoming with regard to the specificity of the requirements of the first order.

H. USEPA and DPNR became aware of another Texaco Service Station (Reese) located at Harwood Highway which was in the process of excavating tanks and installing new tanks due to a failed petro-tight test conducted earlier in July, 1987. Apparent local and federal regulations were violated during the inspection. The acknowledgement of apparent violations led to a meeting scheduled for Thursday morning between USEPA, DPNR and Texaco.

Thursday, July 30, 1987

I. At 1000 hours, a meeting was held at the DPNR office. Representatives from DPNR, USEPA and Texaco were in attendance. At this time, EPA requested Texaco, Corp. be notified of these concerns which were substantiated by the lack of compliance with Virgin Islands regulations displayed at numerous sites on St. Thomas.

Friday, July 31, 1987

J. EPA and DPNR contact well owners Tillett, Harthman, Eglin and Four Winds to discuss sampling results. A request for customer names who purchase their water was made. Each well owner was notified of the excess MCL levels of trichloroethylene found in their wells.

K. DPNR issued an order to Mr. Eric Tillet, President of Tutu Waters to close the Tillett well until further notice.

L. Commissioner Smith verbally requests USEPA to assume the lead on the contamination problem in the Tutu area.

M. EPA recommended DPNR to compile the following: an inventory of all wells both private and commercial, and all underground storage tanks in the Tutu area.

3. FUTURE ACTION:

EPA returns to St. Thomas to undertake the contamination problem in the Tutu area and to assume the role of lead agency.

- EPA will initiate the compilation of inventory of wells and underground storage tanks in the area to identify potential sources of contamination.
- EPA will conduct further sampling of all potential wells for contamination and to further define the extent of contaminants.
- EPA will set up additional well water sampling in the Tutu area.

FINAL POLREP______ FURTHER POLREPS FORTHCOMING X SUBMITTED BY Paula A. Cammarata

Paula A. Cammarata
On-Scene Coordinator
Response & Prevention Branch

DATE OSC RELEASED: Aug 18, 1987

U.S. ENVIRONMENTAL PROTECTION AGENCY

POLLUTION REPORT

DATE: August 8, 1987

Region II
Response and Prevention Branch
Edison, New Jersey 08837

(201) 548-8730 - Commercial & FTS
24 Hour Emergency

TO: C. Daggett, EPA
S. Luftig, EPA
R. Salkie, EPA
F. Rubel, EPA
P. Calabert, EPA
J. Marshall, EPA
ERD Washington (E-Mail)
W. Sawyer, EPA
USCG 7th District (mep)
J. Czapor, EPA
G. Zachos, EPA
B. Sprague, EPA
T. Taccone, EPA
A. Smith, DPNR
J. Lee, DOI
J. Zark, USGS
TAT

POLREP NO.	Three (3)
INCIDENT/SITE NO.:	Tutu Well Site
POLLUTANT:	Gasoline, Solvents, Volatile Organics
CLASSIFICATION:	Major
SOURCE:	Underground gasoline storage tank
LOCATION:	Wheymouth-Rhymer Highway, Tutu St. Thomas, Virgin Islands
AMOUNT:	Unknown, greater than 100 gallons
WATER BODY:	Caribbean Sea, Altantic Ocean and Groundwater

1. SITUATION:

A. See previous POLREP.

2. ACTION TAKEN:

I. Monday, August 3, 1987

A. U.S. EPA arrived on St. Thomas to assist the DPNR with the drafting of orders to Water Haulers, the modification order to Texaco, and the order to well owners identified to be closed.

B. EPA and the DPNR finalized logistics for meeting with Texaco representatives on Wednesday, August 5, 1987.

C. A meeting was held with EPA, Commissioner Smith and DPNR Staff to present the status report of current events and projected schedule of EPA activities. EPA requested two people from the DPNR to be assigned to the Tutu project.

II. Tuesday, August 4, 1987

A. EPA met with DPNR staff to explain the long and short term goals and formally introduce the Tutu well contamination problem to the staff. DPNR assigned Mr. Gregory Rhymer and Mr. Leonard Reed to the TuTu project. This will enable EPA to train these individuals as OSC for future regional actions.

B. EPA recommended DPNR to develop a Task Force. The Task Force is to be comprised of WAPA, VI Housing Authority, VITEMA, Department of Health, Fire Services, Governor's Office, Public Works and Caribbean Research Institute.

C. DPNR initiated activities to identify all commercial, institutional and private wells in the Tutu area. In addition, DPNR contacted well drillers on St. Thomas for further information.

D. EPA requested assistance from U.S. Geological Survey (USGS) hydrogeologic support. EPA initiated activities for th development of a cooperative agreement with U.S. Geological Survey.

E. DPNR initiated activities to identify all underground tanks in the Tutu area.

F. DPNR initiated activities to identify all sources of contamination.

G. DPNR receives petro-tight test results from Texaco indicating Tank #1 is "grossly leaking".

III. Wednesday, August 5, 1987

A. DPNR issued a modified order to Texaco Caribbean Inc.

B. EPA developed logistics for TAT support and sampling of water, soil, sludge, product and waste oil for VOAs and PCBs.

C. Representatives from Texaco, EPA and DPNR met to discuss the issuance of the modified DPNR order which requires Texaco to submit an extensive sampling/contingency plan prior to excavation activities.

D. Task Force meeting was held at the DPNR Office. Representatives from WAPA, VITEMA, DOH, Fire Services, CRI, DPNR and EPA attended. DPW and VIHA were unable to attend.

IV. <u>Thursday, August 6, 1987</u>

A. EPA and DPNR met with VIHA to discuss the laboratory results on July 22, 1987. Well #1 in the Tutu area was sampled. Approximately, 7,000-8,000 people reside within the Housing Projects.

B. EPA and DPNR met with DPW to discuss the identification of alternate water supplies and the feasibility of distributing this water. DPW has only two (2) standpipes for water haulers to unload water. There is also a storage tank adjacent to the Tutu area, which has a 5.5 million gallon or 12 day reserve capacity

C. Two additional underground tanks have been identified in the Tutu area; O'Henry Dry Cleaner, and Home Oil in Ft. Milner.

D. EPA recommended that the DPN identify and contact the private well owners and suggest they not use their wells.

V. <u>Friday, August 7, 1987</u>

A. USGS completes preliminary assessments of wells.

B. Press release was issued to private well owners recommending they cease the use of their wells.

C. DPNR identified fourteen commercial wells, three institutional wells, six private wells, and one public well.

D. DPNR prepared orders to close the following wells: Eglin, Four Winds (Plaza Associates), Harthman, and VIHA. DPNR served order to Harthman and Eglin. Plaza Associates and VIHA cannot be reached.

E. EPA met with Asst. Commissioner Canegata to present a status report of the activities completed and to be scheduled.

VI. <u>Saturday, August 8, 1987</u>

A. DPNR identified ten potential and/or actual sources of contamination to the Tutu Turpentine Run Aquifer.

B. DPNR initiated the creation of a database for each well and source of contamination.

C. Seven well owners have been identified as potential alternate water suppliers.

D. DPNR continued to identify water haulers.

E. DPNR, EPA and EPA/TAT conducted a field investigation of the Tutu area for sampling strategy.

3. <u>FUTURE PLANS AND RECOMMENDATIONS:</u>

A. Complete inventory of all wells in the Tutu area.

B. Complete inventory and investigation of underground storage tanks.

C. Complete listing of water haulers and their customers.

D. DOH will assess health effects with ATSDR (CDC) by setting up a survey system which would further assess the demographics and the need for examination clinics.

FINAL POLREP ___ (TAT) FURTHER POLREPS FORTHCOMING _X_ SUBMITTED BY: Carlos E. O'Neill, P.E.

Carlos O'Neill, OSC
Response and Prevention Branch

DATE RELEASED: 8-20-87

Mentzel

U.S. ENVIRONMENTAL PROTECTION AGENCY

POLLUTION REPORT

DATE: August 18, 1987

Region II
Response and Prevention Branch
Edison, New Jersey 08837

(201) 548-8730 - Commercial & FTS
24 Hour Emergency

TO: C. Daggett, EPA
S. Luftig, EPA
R. Salkie, EPA
F. Rubel, EPA
P. Gelabert, EPA
J. Marshall, EPA
ERD Washington (E-Mail)
W. Sawyer, EPA
USCG 7th District (mep)
J. Czapor, EPA
G. Zachros, EPA
B. Sprague, EPA
T. Taccone, EPA
A. Smith, DPNR
J. Lee, DOI
J. Zack, USGS
TAT

POLREP NO.	Four (4)
INCIDENT/SITE NO.:	Tutu Well Site
POLLUTANT:	Gasoline, Solvents, Volatile Organics
CLASSIFICATION:	Major
SOURCE:	Underground gasoline storage tank
LOCATION:	Wheymouth-Rhymer Highway, Tutu St. Thomas, Virgin Islands
AMOUNT:	Unknown, greater than 100 gallons
WATER BODY:	Caribbean Sea, Altantic Ocean and Groundwater

1. SITUATION:

A. See previous POLREP.

B. EPA press releases allow actions to be covered daily in the local newspaper.

2. ACTION TAKEN:

Sunday August 9, 1987

A. EPA and ATSDR met with Commissioner A. Smith of DPNR to discuss a comprehensive coordinated effort to address the problem at hand. An update of the problem was presented to the Commissioner.

B. EPA and DPNR agreed to develop a comprehensive plan to address public concerns with special emphasis in all media coverage. EPA will develop a Community Relations Plan.

C. EPA and ATSDR meet with Commissioner Smith to discuss sampling of additional water wells and introduce him to the Federal Potable Water Criteria and Guidelines.

Monday August 10, 1987

A. EPA and ATSDR meet with Commissioner Smith of Department of Health to present an update of EPA, DPNR activities.

B. A Task Force Meeting is held to discuss current activities. A press conference is held after the task force.

C. Samples of water were collected from 24 wells in the Tutu area for volatile organic analysis. A total of 16 commercial, 7 private and 1 public well were sampled.

D. A press conference was held and broadcast over local AM Radio. The Commissioner of DPNR and a representative of EPA-OEP were interviewed on local television.

E. DPNR issue a notice to all water hauler not to haul water from Tutu area.

Tuesday August 11, 1987

A. VOA samples were shipped out via express air carrier to York Laboratories in New Jersey.

B. Photovac portable gas chromatography and chemist arrived.

C. ATSDR and VIDOH met to address health related issues. A hotline was set up for people to call about health related problems.

D. DOH notify the adoption of a 5 Point Plan to Governor Farelley, these are the following:

1) Make a comprehensive medical study

2) Set up a hotline

3) Provide specialized training to doctors

4) Identify funds and resources

5) Develop an extensive follow-up examination and/or retesting.

Wednesday August 12, 1987

A. Commissioner Smith of DPNR calls for a meeting with Task Froce representatives. DPNR requests support from agencies during the removal and replacement of water from cisterns. DPNR also states that VI will soon adopt drinking water standards which may impact cisterns in the area.

B. EPA and ATSDR meet with Commissioner Smith to assist him in adoption of Drinking Water Standards.

C. Alternate well water sources were sampled for VOA analysis by photovac.

D. A sample was taken off the top of the well water in Tillets well to determine if free product was present for fingerprinting. No free product was found.

E. A screening procedure for telephone requests of private cistern sampling was adopted. Priority to cisterns having received water from Tillets well since April 1, 1987, will be given and will be sampled for VOA analysis using the photovac.

F. A meeting between EPA, TAT and DPRN was held to discuss the logistics of opening and sampling an abandoned underground gasoline storage tank located in the Fort Mylner Shopping Plaza Area.

G. Approximately 27 water haulers received from DPNR not to have water from the Tutu area and to submit customer names and addresses from April 1, 1987 through July, 1987.

Thursday August 13, 1987

A. A total of 27 cisterns were sampled from three Virgin Islands Housing Authority Projects; Tutu Highrise, Donoe and Bovoni. Fifty five cisterns were identified. However, in the Donoe and Bovoni Projects several cisterns were filled from one centralized tank.

Samples taken:

Project	Sampling Points	# Of Samples
Donoe	Tank, Building #32, control	3
Tutu Highrise	All cisterns	22
Bovoni	Building D, control	2
		27

B. Virgin Isle Hotel will allow EPA to set up the command post in its facility free of charge.

C. In a meeting between DPNR, EPA, TAT, VI Fire Department and VI FEMA it was agreed that the operation of sampling the abandoned underground gasoline storage tank was scheduled to take place Tuesday, August 18, 1987, at 0530 hours. This procedure will be carried out in Level B protection.

D. Photovac equipment fully operational, analysis of samples of Virgin Islands Housing Authority cisterns underway.

E. A meeting between the EPA and USGS was held to discuss the scope of the work that will be done by the USGS on site. USGS will divide tasks into two phases; short term and long term.

Short Term Goals

° Develop mylar from aereal phots
° Draw planimetric map
° Plot sample results
° Complete geologic cross-section

Long Term Goals

° Set up rain gauge
° Set up groundwater recorder
° Use mini monitors
° Collect water samples
and develop another planimetric map
should a big storm event (100 yr. flood) take place

Friday August 15, 1987

A. Photovac analysis of samples for volatile organics continues.

B. Sampling of private cisterns specified by DPNR after initial screening started.

C. A meeting was held between EPA and DPRN to establish VI Drinking Water Standards. No decision has been reached on this matter yet.

Saturday August 16, 1987

A. Sampling of cisterns and photovac analyses for VOC's continues.

B. EPA ERT arrives with a second photovac-GC and prepares the instrument for operation.

3. **FUTURE PLANS AND RECOMMENDATIONS:**

A. Complete inventory of all wells in the Tutu area.

B. Complete inventory and investigation of underground storage tanks.

C. Complete listing of water haulers and their customers.

D. DOH will assess health effects with ATSDR (CDC) by setting up a survey system which would further assess the demographics and examination clinics.

E. VI will establish Drinking Water Standards.

FINAL POLREP____ (TAT)	FURTHER POLREPS FORTHCOMING _X_	SUBMITTED BY: for [illegible] Paula Cammarata, OSC Response and Prevention Branch

DATE RELEASED: 8-27-87

Mentzel

U.S. ENVIRONMENTAL PROTECTION AGENCY

POLLUTION REPORT

DATE: August 24, 1987

Region II
Response and Prevention Branch
Edison, New Jersey 08837

(201) 548-8730 - Commercial & FTS
24 Hour Emergency

TO: C. Daggett, EPA
S. Luftig, EPA
R. Salkie, EPA
F. Rubel, EPA
P. Gelabert, EPA
J. Marshall, EPA
ERD Washington
(E-Mail)
W. Sawyer, EPA
USCG 7th District (mep)
J. Czapor, EPA
G. Zachos, EPA
B. Sprague, EPA
T. Taccone, EPA
A. Smith, DPNR
J. Lee, DOI
J. Zack, USGS
B. Nelson, ATSDR
TAT

POLREP NO.	Five (5)
INCIDENT/SITE NO.:	Tutu Well Site
POLLUTANT:	Gasoline, Solvents, Volatile Organics
CLASSIFICATION:	Major
SOURCE:	Underground gasoline storage tank
LOCATION:	Wheymouth-Rhymer Highway, Tutu St. Thomas, Virgin Islands
AMOUNT:	Unknown, greater than 100 gallons
WATER BODY:	Caribbean Sea, Altantic Ocean and Groundwater

1. **SITUATION:**

A. See previous POLREP.

2. **ACTION TAKEN:**

Monday August 17, 1987

A. EPA/TAT sampling continues; 14 samples collected from 2 wells and 12 cisterns in the Tutu area. Samples analyzed VOA by photovac, no contamination detected in any of the samples.

B. EPA and DPNR met with Texaco Caribbean Inc. and its consultant. Texaco presented their proposed action plan for Texaco Tutu Station. Several issues were discussed:

- Chain of command and decision making for field activities.
- Health and Safety Plan Strategy.
- Identification of individuals and their respective roles.
- Development of a site specific plan.

C. EPA met with ERT representative to discuss the possible use of photovac for soil sampling.

D. EPA met with DPNR Commissioner A. Smith to discuss photovac analysis results. A copy of the analysis report was given to DPNR. A summary of results are as follows: Parameters; benzene, toluene, TCE and PCE.

• Total number of wells sampled:	13
Wells with no detectable amount:	10
Wells with detectable amount:	3
• Total cisterns sample:	32
Cisterns with no detectable amounts:	29
Cisterns with detectable amounts:	3

E. USGS initiates field survey of wells in the Tutu area.

F. A total of twelve (12) waste oil samples were colleted for VOA and PCB analysis. Samples will be shipped off island to a CLP Laboratory.

Tuesday August 18, 1987

A. Sampling continues; 11 cisterns sampled in the Tutu area for VOA analysis by photovac.

B. DPNR Commissioner A. Smith met with water hauler/tank truck owners in an effort to gain their cooperation to identify homeowners that had received water from the Tutu wells during the period of April through July, 1987. This will allow EPA and DPNR to schedule photovac sampling of these cisterns.

C. Resampling of wells for full GS/MS VOC's analysis completed. The following wells and cisterns were resampled:

Wells	Cisterns
St. Thomas Hospital	VIHA Building #4 Tutu
Sookran	VIHA Building #32 Donoe
Lima #6	Tillet
	VIHA Holding Tank Donoe
	Red Hook Plaza

Wednesday August 19, 1987

A. Sampling continues; 10 cisterns sampled in the Tutu area for VOA analysis by photovac.

B. Task Force meeting was held at DPNR Office. Representatives from VITEMA, DOH, Fire Service, VIHA, DPNR and EPA attended. DPW, WAPA, CRI were unable to attend. The followng issues were discussed:

- Status of EPA and DPNR activities
- Photovac test results
- DOH reported they received many phone calls asking for blood and urine tests, but less than 20 persons have gone to the assigned clinic.
- VIHA ask for guidance regarding what sampling for VOC's requirements they could impose to water vendors and well owners to access the quality of the water.

Thursday, August 20, 1987

A. Sampling continues; 10 cisterns sampled in the Tutu area for VOA analysis by photovac.

B. VIHA notifies DPNR of the existence of an old abandoned underground waste oil storage tank at their main office building in Tutu area.

Friday August 21 1987

A. Sampling continues; 9 cisterns sampled in the Tutu area for VOA analysis by photovac.

B. Fifteen water samples shipped to Martin Marietta (CLP Laboratory) for VOA analysis.

C. Commissioner Smith serves three orders to ESSO Standard Oil, Ltd. to stop work at Tutu service station; Newton's water heaters to provide a list of customers, and Plaza Associates to stop utilization of existing well.

3. <u>FUTURE PLANS AND RECOMMENDATIONS</u>:

A. DPNR will adopt drinking water standards for VOC's for well water.

B. EPA/TAT will continue sampling cisterns for photovac analysis.

C. EPA will set a cut off date for calls for sampling of cisterns of Friday, August 28, 1987.

FURTHER POLREPS

FINAL POLREP____ FORTHCOMING _X_ SUBMITTED BY: Carlos E O'Neill, P.E.
(TAT)

Carlos E. O'Neill, OSC
Response and Prevention
Branch

DATE RELEASED: 08-27-87

Mentzel

U.S. ENVIRONMENTAL PROTECTION AGENCY

POLLUTION REPORT

DATE: August 28, 1987

Region II
Response and Prevention Branch
Edison, New Jersey 08837

TO: C. Daggett, EPA
S. Luftig, EPA
J. Marshall, EPA
R. Salkie, EPA
F. Rubel, EPA
ERD Washington
(E-Mail)
W. Sawyer, EPA
USCG 7th District (mep)
J. Czapor, EPA
G. Zachos, EPA
B. Sprague, EPA
P. Gelabert, EPA
T. Taccone, EPA
A. Smith, DPNR
J. Lee, DOI
J. Zack, USGS
B. Nelson, ATSDR
TAT

POLREP NO.	Six (6)
INCIDENT/SITE NO.:	Tutu Well Site
POLLUTANT:	Gasoline, Solvents, Volatile Organics
CLASSIFICATION:	Major
SOURCE:	Underground gasoline storage tank
LOCATION:	Wheymouth-Rhymer Highway, Tutu St. Thomas, U.S. Virgin Islands
AMOUNT:	Unknown, greater than 100 gallons
WATER BODY:	Caribbean Sea, Atlantic Ocean and Groundwater

1. **SITUATION:**

   A. See previous POLREP.

2. **ACTION TAKEN:**

   Monday, August 24, 1987

   A. EPA/TAT sampling continues; 16 samples collected from cisterns in the Tutu area for photovac analysis for VOA compounds.

B. DPNR Commissioner A. Smith held a hearing with ESSO Standard Oil Co., Ltd. regarding the order issued to Tutu ESSO Service Station not to remove underground storage tank without a previously approved action plan. ESSO explained their plan at the hearing. The plan involved visual inspection of tanks by physically entering the tanks followed by cleaning of the tanks by sandblasting. Tanks found to be in condition will be repaired and placed back into service. If leaks are detected in the tanks, additional studies of the area will be conducted to determine the extent of the release.

Tuesday, August 25, 1987

A. EPA/TAT sampling continues; 9 samples collected from cisterns in the Tutu area for photovac analysis for VOA compounds.

B. EPA and DPNR staff met to discuss Texaco's work plan for soil sampling and removal of underground tanks.

C. EPA met with Commissioner Smith of DPNR to discuss well water results and to brief the Commissioner about EPA's removal program. The 175 ppb action level for tetrachloroethylene (PCE) was discussed. This action level was found to be exceeded in three (3) of twenty-four (24) wells sampled in the Tutu area. Commissioner Smith notified EPA that he will adopt the 50/100 ppb criteria (50 ppb for any single VOC or 100 ppb for total VOC's) for drinking water. EPA provided a copy of Puerto Rico's regulations to assist in drafting regulations for the U.S. Virgin Islands.

Wednesday, August 26, 1987

A. EPA and DPNR met with Texaco Caribbean, Inc. to discuss EPA/DPNR comments on Texaco's proposed work plan for soil sampling and underground tank removal at their Tutu service station. The work plan was found to be deficient in several items. A follow-up letter from EPA with both EPA and DPNR comments will be sent to Texaco. Texaco was requested to amend their work plan according to EPA/DPNR comments.

Thursday, August 27, 1987

A. EPA/TAT sampling continues; 6 samples collected from 4 cisterns, one well and one water hauler truck in the Tutu area for photovac analysis for VOA compounds.

B. EPA met with Commissioner A. Smith to develop an action plan using his personnel to assist EPA in all phases of the project (i.e. Research for well information, data entry and management, field inspections and well/cistern surveys, community notification and outreach.

Friday, August 28, 1987

A. EPA/TAT conduct well and cistern inventory questionaire for those private wells targeted for closure.

B. Photovac sampling status to date:

# samples taken for photovac analysis	=	135
# samples analyzed by photovac as of 08/18/87	=	68
# samples tested positive for the five compounds (TCE, DCE, PCE, TOL,& BEN) above the detection limit of 1 ppb	=	1
# samples tested positive for unknown compounds	=	19
# samples for GCMS confirmation	=	17

C. DPNR met with private well home owners to disclose the sampling information. DPNR recommended to the home owners not to drink the well water and to keep alert of the DPNR bulletins.

D. Upon adoption of the interim regulations for VOC's in drinking water, DPNR is planning to close wells that exceed 50 ppb of any single volatile organic compound or 100 ppb for total VOC's.

E. EPA issued a news release concerning final test results for the 24 Tutu wells sampled on August 10 and 11, 1987.

3. <u>FUTURE PLANS AND RECOMENTATIONS:</u>

A. DPNR will adopt drinking water standards for VOC's for well water.

B. EPA will sample wells in the affected area for a complete scan (HSL+40).

C. EPA will continue sampling cisterns in the affected area for photovac analysis.

D. EPA will initiate a well monitoring program of wells in the Tutu area on a weekly basis. Samples will be analyzed using the photovac.

E. EPA is considering initiating a CERCLA action to provide water to those private well home owners with contaminated well water, if the Commissioner closes these wells.

FINAL POLREP   FURTHER POLREPS FORTHCOMING X   SUMITTED BY:

Carlos E. O'Neill, P.E.

Carlos O'Neill, OSC
Response and Prevention Branch

10-21-87

8708-16
1332

Response and Prevention Branch
Edison, New Jersey 08837

To: C. Daggett, EPA
S. Luftig, EPA
J. Marshall, EPA
R. Salkie, EPA
F. Rubel, EPA
J. Marshall, EPA
ERD Washington
(E-Mail)
W. Sawyer, EPA
USCG 7th District (mep)
J. Czapor, EPA
G. Zachos, EPA
B. Sprague, EPA
P. Gelabert, EPA
T. Taccone, EPA
A. Smith, DPNR
J. Lee, DOI
J. Zack, USGS
B. Nelson, ATSDR
TAT

POLREP NO.	Seven (7)
INCIDENT/SITE NO.:	Tutu Well Site (1D)
POLLUTANT:	Solvents, Volatile Organics
CLASSIFICATION:	Major
SOURCE:	Dry Cleaner
LOCATION:	Wheymouth-Rhymer Highway, Tutu St. Thomas, U.S. Virgin Islands
AMOUNT:	Unknown, greater than 100 gallons
WATER BODY:	Caribbean Sea, Atlantic Ocean and Groundwater

1. SITUATION:

A. See previous POLREP.

2. ACTION TAKEN:

Monday, August 31, 1987

A. EPA/TAT sampling continues; 3 samples collected from water haulers in the Tutu area for photovac analysis for VOA compounds.

samples tested positive for unknown compounds = 26

samples for GCMS confirmation = 15

C. Monitoring of the 24 wells in the Turpentine Run Aquifer was initiated and will continue on a monthly basis. Samples were collected from ten wells and will be analyzed by the photovac to determine changes in the concentrations of contaminants in the groundwater.

D. Samples were collected from four(4) cisterns that had previously received water from contaminated wells.

E. At 12:45 hours ERCS was activated to provide services and equipment as specified by the OSC concerning the decontamination of the cisterns and the supply of temporary alternate water sources.

F. DPNR Commissioner A. Smith signed an administrative order adopting drinking water contaminat levels to be applied to the Turpentine Run aquifer.

Wednesday, September 2, 1987

A. At 8:00 hours ERCS subcontractor representative, Clear Ambient arrived at DPNR. EPA required Clear Ambient to be on site to inspect the cisterns to be cleaned.

B. EPA/TAT attended a meeting with the Task Force Committee on the Tutu Well Site. The task force committee members present at this meeting were from EPA, DPNR, University of Virgin Islands, Department of Public Works, VITEMA, VI Housing Authority, Department of Health & Office of the Governor. The meeting addressed the closing of contaminated water wells, the resources needed to clean the cisterns and a means of providing clean water to these residents. Task Force identified Fire Service and the Department of Public Works as those that may provide assistance and/or resources to clean the targeted cisterns. EPA will met with Fire Service and Dept. of Public Works to determine availability of equipment and resources.

C. TAT/DPNR continue to conduct sampling of the 24 wells under the well monitoring program established by EPA during the week of August 24, 1987.

D. EPA/DPNR and the subcontractor hired by ERCS, conducted inspections of the cisterns that will require decontamination.

3. <u>FUTURE PLANS AND RECOMENTATIONS:</u>

B. EPA/TAT continue making arrangements for moving the office to the VITEMA Fort Christian office in Charlotte Amalie.

C. EPA discussed well/cistern questionnaire results with Commissioner of DPNR to decide on advisory letters to be sent to well owners. Also discussed were the drinking water standards to be adopted by DPNR. A standard of 50 ppb for a single volatile organic compound and a standard of 100 ppb for total volatile organic compounds will be adopted by DPNR. This standard will be applied to the Turpentine Run Aquifer and will be effective until December 31, 1988.

D. DPNR Commissioner A. Smith decided to close 5 additional wells. These wells exceeded the proposed V.O.C. levels for drinking water to be adopted.

Tuesday, September 1, 1987

A. At 10:20 hours EPA - OSC received a verbal approval from S. Luftig and Bruce Sprague for a $100,000 removal action at Tutu Well site for:

i) Cisterns cleaning and decontamination.

ii) Disposal of contaminated water.

iii) Rearrangement of cistern plumbing.

iv) Supply water on a regular basis.

v) Establish a well montoring program.

The breakdown of total project cost is as follows:

Mitigation Cost(ERCS)-	$40,000
TAT Cost-	$45,000
EPA Cost-	$15,000
TOTAL PROJECT COST	$100,000

B. Photovac sampling status to date:

# samples taken for photovac analysis	= 158
# samples analyzed by photovac as of 09/01/87	= 151
# samples tested positive for any of the five compounds (TCE, DCE, PCE, TOL, & BEN) above the detection limit of 1 ppb	= 5

A. EPA/TAT will sample wells in the affected area for a complete scan (HSL+40).

B. EPA/TAT will continue sampling cisterns in the affected area for photovac analysis using water haulers clients list.

C. EPA/TAT will continue a well monitoring program of wells in the Tutu area on a monthly basis. Samples will be analyzed using the photovac.

D. EPA will initiate the cleaning of contaminated cisterns and will provide clean water by tank trucks on a regular basis.

4. FINANCIAL ACCOUNTING:

A. Total Project Ceiling Authorized $ 100,000

B. Total Funds Authorized for Mitigation for Mitigation Contracts 68-01-7445 $ 40,000

C. Expenditures for Mitigation Contracts

1.a. Amount Obligated to DCN KCS 112 $ 30,000

1.b. Estimated Expenditures as of 02/09/87 $________

1.c. Balance remaining $________

D. Unobligated Balance Remaining $________

E. Estimate of Total Exenditures to Date for all Mitigation Contracts $________

F. Other Extramural Costs

1.a. TAT Salary/travel/expenses $________

G. Intramural Removal Costs

1.a. EPA travel and salaries $________

H. Total Expenditures % of $2 Million $________ ____%

I. Percentage of Total Project Ceiling ____%

FURTHER
POLREPS
FINAL POLREP ____ FORTHCOMING X SUBMITTED BY: Carlos E O'Neill

Carlos O'Neill, OSC
Response and Prevention
Branch

DATE RELEASED: Sept. 2, 1987

U.S. ENVIRONMENTAL PROTECTION AGENCY

POLLUTION REPORT

DATE: September 4, 1987

Region II
Response and Prevention Branch
Edison, New Jersey 08837

TO: C. Daggett, EPA
S. Luftig, EPA
J. Marshall, EPA
R. Salkie, EPA
F. Rubel, EPA
J. Marshall, EPA
ERD Washington
(E-Mail)
W. Sawyer, EPA
USCG 7th District (mep)
J. Czapor, EPA
G. Zachos, EPA
B. Sprague, EPA
P. Gelabert, EPA
T. Taccone, EPA
A. Smith, DPNR
J. Lee, DOI
J. Zack, USGS
B. Nelson, ATSDR
TAT

POLREP NO.	Eight (8)
INCIDENT/SITE NO.:	Tutu Well Site (1D)
POLLUTANT:	Solvents, Volatile Organics
CLASSIFICATION:	Major
SOURCE:	Dry Cleaners, Auto Repair Shops
LOCATION:	Wheymouth-Rhymer Highway, Tutu St. Thomas, U.S. Virgin Islands
AMOUNT:	Unknown, greater than 100 gallons
WATER BODY:	Caribbean Sea, Atlantic Ocean and Groundwater

1. <u>SITUATION</u>:

A. See previous POLREP.

2. <u>ACTION TAKEN</u>:

Thursday, September 3, 1987

A. EPA/TAT continues photovac analysis for VOA on well samples collected Wednesday, September 2, 1987.

B. EPA has projected to complete the removal action at the Tutu Well Site by Friday, September 11, 1987. This includes:

i) cleaning and decontamination of the cisterns;

ii) disposal of the contaminated water;

iii) rearrangement of cistern plumbing where necessary;

iv) supplying water on a regular basis; and

v) establishing a well montoring program.

The breakdown of total monies allocated for this removal is as follows:

Mitigation Cost(ERCS)-	$40,000
TAT Cost-	$45,000
EPA Cost-	$15,000
TOTAL PROJECT ALLOCATION	$100,000

C. Photovac sampling status to date:

# samples taken for photovac analysis	= 183
# samples analyzed by photovac as of 09/04/87	= 183
# samples tested positive for any of the five compounds (TCE, DCE, PCE, TOL, & BEN) above the detection limit of 1 ppb	= 10
# samples tested positive for unknown compounds	= 26
# samples for GCMS confirmation	= 15

D. EPA/TAT completes initial phase of well monitoring program which includes collection of samples from 24 wells.

E. EPA and ERCS subcontractor inspected all cisterns to be cleaned and decontaminated during the week of September 8, 1987.

F. DPNR, Department of Health and EPA conducted a meeting with the owners of the contaminated wells and their tenants. DPNR announced that a total of five wells would be closed. Three owners received orders to close their wells and two received advisory letters to close their wells effective Friday, September 4, 1987.

The tenants and well owners had the opportunity to discuss any health related issues with representatives from the Department of Health.

Friday, September 4, 1987

A. EPA/TAT has complete the cistern sampling effort for photovac analysis for VOA.

B. EPA/TAT has completed photovac analysis on all samples collected as of this date, Friday, September 4, 1987.

C. EPA met Commissioner A. Smith to discuss the removal activities to be carried out during the week of September 8, 1987.

D. EPA released a news bulletin to the press regarding its removal activities in the Tutu Well Site.

E. EPA and ERCS Subcontractor developed a work schedule to initiate cisterns clean up activities by Tuesday, September 8, 1987.

3. <u>FUTURE PLANS AND RECOMENTATIONS:</u>

A. EPA/TAT will sample wells in the affected area for a complete scan (HSL+40).

B. EPA/TAT will continue a well monitoring program of wells in the Tutu area on a monthly basis. Samples will be shipped to Edison, N.J. and analyzed using the photovac.

C. The subcontractor hired by ERCS will initiate the cleaning of the contaminated cisterns following the procedure outlined by EPA/TAT and will provide clean water by tank trucks on a regular basis.

D. DPNR will compile background information on all wells in the Turpentine Run Area before EPA conducts further action.

E. DPNR will complete report on potential sources of contamination in the Turpentine Run Aquifer.

4. FINANCIAL ACCOUNTING:

A.	Total Project Ceiling Authorized	$	100,000.00
B.	Total Funds Authorized for Mitigation for Mitigation Contracts 68-01-7445	$	40,000.00
C.	Expenditures for Mitigation Contracts		
1.a.	Amount Obligated to DCN KCS 112	$	30,000.00
1.b.	Estimated Expenditures as of 09/03/87	$	935.05
1.c.	Balance remaining	$	29,064.95
D.	Unobligated Balance Remaining	$	10,000.00
E.	Estimate of Total Exenditures to Date for all Mitigation Contracts	$	935.05
F.	Other Extramural Costs		
1.a.	TAT Salary/travel/expenses	$	2,015.00
G.	Intramural Removal Costs		
1.a.	EPA travel and salaries	$	940.00
H.	Total Expenditures	$	3890.05
	% of $2 Million		0.02 %
I.	Percentage of Total Project Ceiling		3.90 %

FINAL POLREP_____ FURTHER POLREPS FORTHCOMING X SUBMITTED BY: Carlos E. O'Neill

Carlos O'Neill, OSC
Response and Prevention Branch

DATE RELEASED: Sept. 8, 1987

U.S. ENVIRONMENTAL PROTECTION AGENCY

POLLUTION REPORT

DATE: September 18, 1987

Region II
Response and Prevention Branch
Edison, New Jersey 08837

TO: C. Daggett, EPA
S. Luftig, EPA
J. Marshall, EPA
R. Salkie, EPA
F. Rubel, EPA
ERD Washington (E-Mail)
W. Sawyer, EPA
USCG 7th District
J. Czapor, EPA
G. Zachos, EPA
B. Sprague, EPA
P. Gelabert, EPA
T. Taccone, EPA
A. Smith, DPNR
J. Lee, DOI
J. Zack, USGS
B. Nelson, ATSDR
TAT

POLREP NO.:	Nine (9)
INCIDENT/SITE NO.:	Tutu Well Site
POLLUTANT:	Solvents, Volatile Organics
CLASSIFICATION:	Major
SOURCE:	Dry Cleaners
LOCATION:	Wheymouth-Rhymer Highway, Tutu St. Thomas, U.S. Virgin Islands
AMOUNT:	Unknown, greater than 100 gallons
WATER BODY:	Caribbean Sea, Atlantic Ocean and Groundwater

1. SITUATION:

   A. See previous POLREP

2. ACTION TAKEN:

   Tuesday, September 8, 1987

   A. ERCS subcontractor starts cleanup of contaminated cisterns. Cleanup procedure is as follows: cistern is drained, washed with a pressure hose, disinfected with a chlorine solution and filled with drinking water from the desalt plant.

B. Equipment breakdown slows cistern cleanup activity. ERCS subcontractor completes the cleanup of two chambers of a five chamber cistern at Steele apartments.

C. A report on water haulers was prepared.

D. Database on photovac sampling results finished.

E. EPA/ERCS Met with Chuck Klim, a water hauler selected by Clear Ambient, to discuss the water delivery procedure.

Wednesday September 9, 1987

A. ERCS subcontractor finished cleaning the three remaining chambers of Steeles cistern and cleaned Harvey's cistern.

B. A map showing wells locations and possible responsible parties in the Turpentine Run aquifer area was prepared.

C. DPNR continues preparing a report on potential sources of contamination in the Turpentine Run aquifer area.

D. Data entry on well inventory data base continues.

Thursday September 10, 1987

A. ERCS subcontractor finished the cleanup of the two remaining cisterns at Steele's apartments.

B. A sampling plan for HSL was prepared.

Friday September 11, 1987

A. ERCS subcontractor finished cleaning the two chambers at Smith's cisterns.

B. DPNR finishes report on potential responsible parties (PRP).

C. Databases on wells, PRP's and photovac final results finished.

D. EPA met with Commissioner A. Smith to report all accomplishments so far and to brief him on EPA's future activities.

E. EPA developed a procedure and written instructions for well owners on how to request water for their cisterns.

Saturday, September 12, 1987

A. EPA/ERCS met with Chuck Klim to discuss the procedures on how to provide and deliver water to qualified well owners.

B. EPA met with each well owner to give them written instructions on how to request water. Each owner received a package of instructions and their questions were answered.

3. <u>FUTURE PLANS AND RECOMMENDATIONS</u>

A. EPA/TAT/DPNR will sample wells in the affected area for a complete scan (HSL+40).

B. EPA/TAT/DPNR will continue a well monitoring program of wells in the Tutu area on a monthly basis. Samples will be shipped to Edison, N.J. and analysed for VOC's using the photovac.

C. EPA will continue enforcement activities to identify potential responsible parties.

4. <u>FINANCIAL ACCOUNTING</u>

A.	Total Project Ceiling Authorized		$100,000.00
B.	Total Funds Authorized for Mitigation for Mitigation Contracts 68-01-7445		$ 30,000.00
C.	Expenditures for Mitigation Contracts		
	1.a	Amount obligated to DCN KCS 112	$ 30,000.00
	1.b	Estimated Expenditures as of 09/12/87	$ 13,283.25
	1.c	Balance Remaining	$ 16,716.75
D.	Unobligated Balance Remaining		$ 10,000.00
E.	Estimate of Total Expenditures to Date for all Mitigation Contracts		$ 13,283.25

F. Other Extramural Costs

1.a	TAT Salary/travel/expenses as of 09/12/87	$ 5,990.00

G. Intramural Removal Costs

1.a	EPA travel and salaries	$ 3,690.00

H.	Total Expenditures	$ 22,963.25
	% of $2 Million	1.1%
I.	Percentage of Total Project Ceiling	22.9%

FINAL POLREP ____ FURTHER POLREPS FORTHCOMING __X__ SUBMITTED BY: Carlos E. O'Neill

Carlos E. O'Neill, OSC
Caribbean Field Office
Response and Prevention
Branch

DATE RELEASED: 09|18|87

APPENDIX D

APPENDIX E

APPENDIX C

WESTON SPER

Suite 201, 1090 King Georges Post Road.
Edison, NJ 08837 • 201 225-6116

TECHNICAL ASSISTANCE TEAM FOR EMERGENCY RESPONSE REMOVAL AND PREVENTION
EPA CONTRACT 68-01-7367

TAT-02-F-04393 **MEMORANDUM**

TO: Carlos O'Neill
U.S EPA Caribbean Field Office

FROM: Arnaldo Martinez, TAT II PM
Douglas Henne, TAT II QC

SUBJECT: St. Thomas, Tutu HSL + 40
Sampling Results

DATE: January 27, 1988

The following letter report is provided in accordance with TDD #02-8709-29.

The completed analysis report of the HSL+40 sampling of the Tutu well site was received on January 18, 1988. A copy of the laboratory report was delivered to the EPA PM on January 20, 1988.

Table #1 shows the concentration of contaminants found in each well. The major contaminants found are 1,2-transdichloroethylene (DCE), trichloroethylene (TCE), tetrachloroethylene (PCE) and tertbutyl methyl ether (TBME). TBME was not detected during previous samplings. Other compounds found in low or trace concentration are: 1,1,1-trichloroethane; benzoic acid; 4-methoxy-1,1-dimethyl ethyl phenol; 2-butoxyethyl phosphate; 1,2-dichlorobenzene; 2-ethyl-1-hexanol; N-2-dimethyl -1- propaneamine; chloroform; toluene; pentachlorphenol, methylene chloride and 2-methyl naphtalene.

A high concentration (120,000 ug/l) of methylene chloride was found in the Harvey's Well. Toluene was detected in low or trace concentrations in two wells (Byran's and Leonard's). Unlike previous samplings, benzene was not detected in any of the sampled wells.

The following wells show no detectable concentration of any of the organic compounds tested: Rodriguez Auto, Devcon #1, Devcon #3, Dench, and Harthman Estate.

Table #2 shows the compounds and metals that are regulated under CERCLA, their reportable quantities (RQ) and their Drinking Water Standards Maximum Contaminant Level (MCL), if any.

Of the metals tested, arsenic, selenium and zinc were found in greater than trace concentrations. Arsenic was found only in the Harthman Crusher Well. Zinc concentrations ranged from nondetectable in Devcon #1 to 460 ug/l in Smith Well. Other metals found in detectable but not quantifiable concentrations are chromium, copper, thallium and antimony. The concentration of metals found in each well is listed in Table #1.

Cyanide was found in five wells. The concentrations ranged from detectable but not quantifiable (trace), to 58 ug/l in Eglin #1 well. The concentration of cyanide found in each well is listed in Table #1.

The HSL+40 sampling results confirm that the major pollutants in the Tutu well site are DCE, TCE and PCE. Seven wells show concentrations greater or equal to 100 ppb of one or more of these compounds.

A new major contaminant was found in this sampling. Six wells show a concentration greater or equal to 100 ppb of tertbutyl methyl ether.

Benzene was not detected in any of the samples taken for this analysis. Previous analysis with the photovac portable chromatograph and GCMS confirmation samples had shown concentrations greater than 1000 ppb in the Tillet Well. This was also found in the photovac samples for the month of November. Samples for photovac analyis taken concurrently with the HSL samples show a concentration of 46 ppb of benzene in the Tillet Well.

The cause of this discrepancy is unknown at present, TAT will review previous data to identify potential causes for this occrrence as well as discuss the analysis with the presently contracted laboratory.

TABLE 1
CONTAMINANT CONCENTRATIONS (ug/l) FOUND
IN TUTU WELL SITE

Bryan's Well		
Toluene	Trace	
Zinc	Trace	
Tillet's Well		
1,2-transdichloroethylene	600	
Trichloroethylene	25	
Tetrachloroethylene	140	
Tertbutylmethyl ether	470	
1,2-dichlorobenzene	Trace	
Trichlorobenzene	Trace	
2-methyl naphtalene	Trace	
Chromium	Trace	
Copper	Trace	
Four Winds Plaza #1		
1,2-transdichloroethylene	280	
Trichloroethylene	18	
Tetrachloroethylene	140	
Tertbutylmethyl ether	470	
Chromium	Trace	
Copper	Trace	
Zinc	51	
Elgin #3		
1,2-transdichloroethylene	78	
Trichloroethylene	8.4	
Tetrachloroethylene	40	
Tertbutylmethyl ether	270	estimated
Chromium	Trace	
Copper	Trace	
Thallium	Trace	
Zinc	98	
Eglin #2		
1,2-transdichloroethylene	57	
Trichloroethylene	7.5	
Tetrachloroethylene	21	
Tertbutylmethyl ether	390	estimated
Copper	Trace	
Zinc	200	

TABLE 1
CONTAMINANT CONCENTRATIONS (ug/l) FOUND
IN TUTU WELL SITE
(Continued)

Eglin #1

1,2-transdichloroethylene	56	
Trichloroethylene	10	
Tetrachloroethylene	100	
Tertbutylmethyl ether	270	estimated
Copper	Trace	
Zinc	82	
Cyanide	58	

Francois Well

1,2-transdichloroethylene	100	
Trichloroethylene	15	
Tetrachloroethylene	130	
Tertbutylmethyl ether	180	estimated
Chromium	Trace	
Zinc	Trace	
Cyanide	Trace	

VIHA #1

1,2-transdichloroethylene	4.9	
1,1,1-trichloroethane	Trace	
Trichloroethylene	Trace	
Tetrachloroethyelne	Trace	
Benzoic Acid	Trace	
Copper	Trace	
Zinc	Trace	
Cyanide	23	

VIHA #3

Methylene chloride	6.9	
Trichloroethylene	Trace	
Benzoic acid	Trace	
4-methoxy-1,1-dimethyl ethyl phenol	2.1	estimated
2-butoxy ethyl phosphate	3.1	estimated
Copper	Trace	
Selenium	Trace	
Zinc	Trace	
Cyanide	Trace	

TABLE I
CONTAMINANT CONCENTRATIONS (ug/L) FOUND
IN TUTU WELL SITE
(Continued)

<u>Demitri's Well</u>	
Tetrachloroethylene	Trace
Copper	20 estimated
Selenium	Trace
Zinc	40 estimated
<u>Harthman Estate Well</u>	
Selenium	Trace
Zinc	Trace
<u>Rodriguez Auto Well</u>	
Copper	Trace
Zinc	Trace
<u>Ramsey Motors Well</u>	
1,2-transdichloroethylene	6.3
Trichloroethylene	Trace
Tetrachloroethylene	22
Antimony	Trace
Zinc	Trace
Cyanide	Trace
<u>Steele's Well</u>	
1,2-transdichloroethylene	47
Trichloroethylene	15
Tetrachloroethylene	320
Tertbutylmethyl ether	37
1,2-dichlorobenzene	Trace
Chromium	Trace
Copper	Trace
Antimony	Trace
Zinc	Trace
<u>Harvey's Well</u>	
Methylene chlorde	120,000
1,2-transdichloroethylene	49
Trichloroethylene	23
Tetrachloroethylene	2,000
Chromium	Trace
Copper	Trace
Zinc	340

TABLE 1
CONTAMINANT CONCENTRATIONS (ug/l) FOUND
IN TUTU WELL SITE
(Continued)

Mathias

Trichloroethylene	Trace	
Tetrachloroethylene	3.6	
2-ethyl-1-hexanol	4.7	estimated
N,2-dimethyl-1-propaneamine	32	estimated
Copper	Trace	
Selenium	5.6	
Zinc	Trace	

Smith's Well

1,2-transdichloroethylene	100	
Chloroform	Trace	
Trichloroethylene	21	
Tetrachloroethylene	150	
Tertbutylmethyl ether	34	estimated
Copper	7	
Selenium	3	
Zinc	460	

Devcon #1 Well

None detected

Devcon #3 Well

Chromium	Trace
Selenium	7.1
Zinc	Trace

Alpha Leonard Well

Tetrachloroethylene	Trace
Toluene	22
Selenium	8.5

DeDe Well

Pentachlorophenol	Trace
Copper	Trace
Zinc	Trace

TABLE 1
CONTAMINANT CONCENTRATIONS (ug/l) FOUND
IN TUTU WELL SITE
(Continued)

Harthman Crusher Well

1,2-transdichloroethylene	Trace
Trichloroethylene	Trace
Tetrachloroethylene	6.2
Arsenic	15
Zinc	Trace

Dench Well

Copper	Trace
Antimony	Trace
Thallium	12
Zinc	68

Harthman Bakery Well

1,2-transdichloroethylene	Trace
Trichloroethylene	Trace
Benzoic acid	Trace
Antimony	Trace
Zinc	Trace

NOTE: These results have been corrected for contaminants found in the field blanks and laboratory blanks.

TABLE 2
REGULATED COMPOUNDS

COMPOUND NAME	CERCLA REG.	RQ (Pds)	MCL (ug/l	RMCL (ug/l
1,2-transdichloroethylene	X	1,000		
Trichloroethylene	X	1,000		
Tetrachloroethylene	X	1		
Tertbutylmethyl ether				
1,1,1-trichloroethane	X	1,000	200	
Benzoic acid	X	5,000		
Methylene chloride	X	1,000		
4-metoxy-1,1-dimethyl ethyl phenol				
2-butoxy ethyl phosphate				
1,2-dichlorobenzene	X	100		
2,ethyl-1- hexanol				
N,2-dimethyl-1-propaneamine				
Chloroform	X	5,000	100 (total trihalomethane)	
Toluene	X	1,000		
Pentachlorophenol	X	10		
2-methyl naphtalene				
Chromium	X	1 (dusts)	50	
Copper	X	1 (dusts)		1,000
Zinc	X	1 (dusts)		
Cyanide	X	1 (dusts)		
Thallium	X	1 (dusts)		
Selenium	X	1 (dusts)	10	
Antimony	X	1 (dusts)		
Arsenic	X	1 (dusts)	50	

COMPLETED ANALYSIS REPORT   REPORT DATE: 87/11/

PROJECT NO: 253   PROJECT NAME: TURPENTINE RUN

EXPLANATIONS OF REMARK CODES

REMARK CODE	EXPLANATION
B	RESULTS BASED UPON COLONY COUNTS OUTSIDE ACCEPTABLE RANGE
J	ESTIMATED VALUE
K	ACTUAL VALUE KNOWN TO BE LESS THAN VALUE GIVEN
L	ACTUAL VALUE KNOWN TO BE GREATER THAN VALUE GIVEN
N	PRESENCE OF MATERIAL VERIFIED BUT NOT QUANTIFIED
O	SAMPLED BUT NOT ANALYZED DUE TO LAB ACCIDENT
T	REPORTED VALUE LESS THAN CRITERIA OF DETECTION
U	MATERIAL ANALYZED FOR, BUT NOT DETECTED

LOCATION CODES FOR IDENTIFICATION OF SAMPLING POINTS AT INDUSTRIAL / SANITARY FACILITIES, LANDFILLS, HAZARDOUS WASTE SITES.

CODE NUMBERS	SAMPLING POINTS
1001 - 1050	EFFLUENT PIPE NUMBER 001 TO 050
1051 - 1099	OTHER EFFLUENTS SUCH AS COOLING TOWER DISCHARGE, DISCHARGE FROM HOLDING PONDS, ETC...
1100 - 1249	IN PLANT SAMPLES - DURING PROCESS
1250 - 1274	IN PLANT SAMPLES AFTER PROCESS AND BEFORE TREATMENT OR DISCHARGE
1275 - 1424	IN PLANT SAMPLES - DURING TREATMENT
1435 - 1454	SEPARATE INFLUENT POINTS/WATER SOURCES
19XX	INFLUENT ASSOCIATED WITH EFFLUENT 10XX
1900	BLANK FOR VOLATILE ORGANICS
2XXX	AUTO SAMPLER BLANK AT SAMPLE POSITION 1XXX
3000 - 3099	GROUND WATER FROM WELL 01 TO 99
3100 - 3199	SEDIMENT SAMPLE (WATER BOTTOM)
3200 - 3299	SOIL SAMPLE
3300 - 3399	STREAM WATER SAMPLE
3400 - 3499	LAGOON SAMPLE
3500 - 3599	STORAGE TANK SAMPLE
3600 - 3699	LEACHATE SAMPLE
3700 - 3799	OTHER TYPE SAMPLE

RECEIVED
NOV 30 1987
S & M BRANCH

COMPLETED ANALYSIS REPORT — REPORT DATE: 87/11

PROJECT NO: 293 — PROJECT NAME: TURPENTINE RUN

TION NO	DATE FROM TO	TIME OF DAY	LABNO	PARMC	PARAMETER NAME	UNITS	CHEMISTRY	VALUE : REM
.RUN	87/10/05	1000						
ME: 0000 SUBSTRATE: AQUEOUS								
CRIPTION: FIELD BLANK								
			390776	01077	SILVER	UG/L	TOTAL	[illegible]
				01002	ARSENIC	UG/L	TOTAL	1
				01012	BERYLLIUM	UG/L	TOTAL	1
				01027	CADMIUM	UG/L	TOTAL	5
				01034	CHROMIUM	UG/L	TOTAL	[illegible]
				01042	COPPER	UG/L	TOTAL	[illegible]
				71900	MERCURY	UG/L	TOTAL	[illegible]
				01051	LEAD	UG/L	TOTAL	[illegible]
				01067	NICKEL	UG/L	TOTAL	[illegible]
				01097	ANTIMONY	UG/L	TOTAL	[illegible]
				01147	SELENIUM	UG/L	TOTAL	[illegible]
				01059	THALLIUM	UG/L	TOTAL	[illegible]
				01092	ZINC	UG/L	TOTAL	10
				00720	CYANIDE	MG/L	TOTAL	0.015
.RUN	87/10/05	1123						
ME: 0000 SUBSTRATE: AQUEOUS								
RIPTION: BRYAN WELL #1 FROM STANDPIPE.								
			390777	01077	SILVER	UG/L	TOTAL	[illegible]
				01002	ARSENIC	UG/L	TOTAL	[illegible]
				01012	BERYLLIUM	UG/L	TOTAL	1
				01027	CADMIUM	UG/L	TOTAL	5
				01034	CHROMIUM	UG/L	TOTAL	[illegible]
				01042	COPPER	UG/L	TOTAL	[illegible]
				71900	MERCURY	UG/L	TOTAL	[illegible]
				01051	LEAD	UG/L	TOTAL	[illegible]
				01067	NICKEL	UG/L	TOTAL	[illegible]
				01097	ANTIMONY	UG/L	TOTAL	[illegible]
				01147	SELENIUM	UG/L	TOTAL	[illegible]
				01059	THALLIUM	UG/L	TOTAL	[illegible]
				01092	ZINC	UG/L	TOTAL	[illegible]
				00720	CYANIDE	MG/L	TOTAL	0.014
.RUN	87/10/05	1225						
ME: 0000 SUBSTRATE: AQUEOUS								
CRIPTION: TILLET WELL								
			390778	01077	SILVER	UG/L	TOTAL	[illegible]
				01002	ARSENIC	UG/L	TOTAL	1
				01012	BERYLLIUM	UG/L	TOTAL	[illegible]

COMPLETED ANALYSIS REPORT

REPORT DATE: 87/1

PROJECT NO: 253

PROJECT NAME: TURPENTINE RUN

STATION NO	DATE FROM TO	TIME OF DAY	LABNO	PARNO	PARAMETER NAME	UNITS	CHEMISTRY	VALUE
			393778	01027	CADMIUM	UG/L	TOTAL	4
				01034	CHROMIUM	UG/L	TOTAL	3
				01042	COPPER	UG/L	TOTAL	[illegible]
				71900	MERCURY	UG/L	TOTAL	.2
				01051	LEAD	UG/L	TOTAL	[illegible]
				01067	NICKEL	UG/L	TOTAL	23
				01097	ANTIMONY	UG/L	TOTAL	[illegible]
				01147	SELENIUM	UG/L	TOTAL	1
				01059	THALLIUM	UG/L	TOTAL	[illegible]
				01092	ZINC	UG/L	TOTAL	13
				00720	CYANIDE	MG/L	TOTAL	[illegible]

P. RUN 87/10/05 1340
PTH: 0000 SUBSTRATE: AQUEOUS
SCRIPTION: [illegible] WELL #1

STATION NO	DATE FROM TO	TIME OF DAY	LABNO	PARNO	PARAMETER NAME	UNITS	CHEMISTRY	VALUE
			393779	01077	SILVER	UG/L	TOTAL	22
				01002	ARSENIC	UG/L	TOTAL	1
				01012	BERYLLIUM	UG/L	TOTAL	1
				01027	CADMIUM	UG/L	TOTAL	4
				01034	CHROMIUM	UG/L	TOTAL	5
				01042	COPPER	UG/L	TOTAL	5
				71900	MERCURY	UG/L	TOTAL	.2
				01051	LEAD	UG/L	TOTAL	30
				01067	NICKEL	UG/L	TOTAL	23
				01097	ANTIMONY	UG/L	TOTAL	1
				01147	SELENIUM	UG/L	TOTAL	1
				01059	THALLIUM	UG/L	TOTAL	1
				01092	ZINC	UG/L	TOTAL	51
				00720	CYANIDE	MG/L	TOTAL	0.014

P. RUN 87/10/05 1500
PTH: 0000 SUBSTRATE: AQUEOUS
SCRIPTION: [illegible] WELL #3

STATION NO	DATE FROM TO	TIME OF DAY	LABNO	PARNO	PARAMETER NAME	UNITS	CHEMISTRY	VALUE
			393780	01077	SILVER	UG/L	TOTAL	[illegible]
				01002	ARSENIC	UG/L	TOTAL	1
				01012	BERYLLIUM	UG/L	TOTAL	1
				01027	CADMIUM	UG/L	TOTAL	4
				01034	CHROMIUM	UG/L	TOTAL	5
				01042	COPPER	UG/L	TOTAL	5

COMPLETED ANALYSIS REPORT — REPORT DATE: 07/[illegible]

PROJECT NO: [illegible] — PROJECT NAME: TURPENTINE RUN

TION NO	DATE FROM TO	TIME OR DAY	LABNO	STORNO	PARAMETER NAME	UNITS	CHEMISTRY	VALUE
			090732	01097	ANTIMONY	UG/L	TOTAL	[illegible]
				01147	SELENIUM	UG/L	TOTAL	[illegible]
				01059	THALLIUM	UG/L	TOTAL	[illegible]
				01092	ZINC	UG/L	TOTAL	[illegible]
				00720	CYANIDE	MG/L	TOTAL	[illegible]
. RUN	07/10/85	1755						
H: 0003 SUBSTRATE: AQUEOUS								
RIPTION: FRANCISCO WELL								
			090733	01077	SILVER	UG/L	TOTAL	[illegible]
				01002	ARSENIC	UG/L	TOTAL	[illegible]
				01012	BERYLLIUM	UG/L	TOTAL	[illegible]
				01027	CADMIUM	UG/L	TOTAL	[illegible]
				01034	CHROMIUM	UG/L	TOTAL	[illegible]
				01042	COPPER	UG/L	TOTAL	[illegible]
				71900	MERCURY	UG/L	TOTAL	[illegible]
				01051	LEAD	UG/L	TOTAL	[illegible]
				01067	NICKEL	UG/L	TOTAL	[illegible]
				01097	ANTIMONY	UG/L	TOTAL	[illegible]
				01147	SELENIUM	UG/L	TOTAL	1
				01059	THALLIUM	UG/L	TOTAL	[illegible]
				01092	ZINC	UG/L	TOTAL	139
				00720	CYANIDE	MG/L	TOTAL	[illegible]
. RUN	07/10/87	0355						
H: 0003 SUBSTRATE: AQUEOUS								
CRIPTION: VISTA HOUSING WELL #1								
			090734	01077	SILVER	UG/L	TOTAL	[illegible]
				01002	ARSENIC	UG/L	TOTAL	[illegible]
				01012	BERYLLIUM	UG/L	TOTAL	[illegible]
				01027	CADMIUM	UG/L	TOTAL	[illegible]
				01034	CHROMIUM	UG/L	TOTAL	[illegible]
				01042	COPPER	UG/L	TOTAL	[illegible]
				71900	MERCURY	UG/L	TOTAL	[illegible]
				01051	LEAD	UG/L	TOTAL	[illegible]
				01067	NICKEL	UG/L	TOTAL	[illegible]
				01097	ANTIMONY	UG/L	TOTAL	[illegible]
				01147	SELENIUM	UG/L	TOTAL	[illegible]
				01059	THALLIUM	UG/L	TOTAL	[illegible]

COMPLETED ANALYSIS REPORT — REPORT DATE: 87/1[illegible]

PROJECT NO: [illegible] — PROJECT NAME: TURPENTINE RUN

STATION NO	DATE FROM / TO	TIME OR DAY	LABNO	PARNO	PARAMETER NAME	UNITS	CHEMISTRY	VALUE / REMARK
			390794	01092	ZINC	UG/L	TOTAL	10
				00720	CYANIDE	MG/L	TOTAL	0.023

RUN 87/10/07 0910
[illegible] CODE: 1700 SUBSTRATE: AQUEOUS
DESCRIPTION: VIHA HOUSING WELL #3

LABNO	PARNO	PARAMETER NAME	UNITS	CHEMISTRY	VALUE / REMARK
390795	01077	SILVER	UG/L	TOTAL	[illegible]
	01002	ARSENIC	UG/L	TOTAL	1
	01012	BERYLLIUM	UG/L	TOTAL	[illegible]
	01027	CADMIUM	UG/L	TOTAL	[illegible]
	01034	CHROMIUM	UG/L	TOTAL	[illegible]
	01042	COPPER	UG/L	TOTAL	[illegible]
	71900	MERCURY	UG/L	TOTAL	[illegible]
	01051	LEAD	UG/L	TOTAL	[illegible]
	01067	NICKEL	UG/L	TOTAL	[illegible]
	01097	ANTIMONY	UG/L	TOTAL	[illegible]
	01147	SELENIUM	UG/L	TOTAL	[illegible]
	01059	THALLIUM	UG/L	TOTAL	1
	01092	ZINC	UG/L	TOTAL	30
	00720	CYANIDE	MG/L	TOTAL	0.019

RUN 87/10/07 1045
STATION CODE: 1700 SUBSTRATE: AQUEOUS
DESCRIPTION: HARTMAN ESTATE WELL

LABNO	PARNO	PARAMETER NAME	UNITS	CHEMISTRY	VALUE / REMARK
390796	01077	SILVER	UG/L	TOTAL	[illegible]
	01002	ARSENIC	UG/L	TOTAL	1
	01012	BERYLLIUM	UG/L	TOTAL	1
	01027	CADMIUM	UG/L	TOTAL	5
	01034	CHROMIUM	UG/L	TOTAL	5
	01042	COPPER	UG/L	TOTAL	[illegible]
	71900	MERCURY	UG/L	TOTAL	.2
	01051	LEAD	UG/L	TOTAL	[illegible]
	01067	NICKEL	UG/L	TOTAL	[illegible]
	01097	ANTIMONY	UG/L	TOTAL	[illegible]
	01147	SELENIUM	UG/L	TOTAL	[illegible]
	01059	THALLIUM	UG/L	TOTAL	[illegible]
	01092	ZINC	UG/L	TOTAL	[illegible]
	00720	CYANIDE	MG/L	TOTAL	0.017

PAG[illegible]

COMPLETED ANALYSIS REPORT

REPORT DATE: 87/[illegible]

PROJECT NO: 253

PROJECT NAME: TURPENTINE RUN

STATION NO	DATE FROM TO	TIME OF DAY	LABNO	PARNO	PARAMETER NAME	UNITS	CHEMISTRY	VALUE + [illegible]
[illegible]P.RUN	87/10/07	1303						
STATION CODE: 3700 SUBSTRATE: AQUEOUS								
DESCRIPTION: DEMITRIS WELL								
			090797	01077	SILVER	UG/L	TOTAL	[illegible]
				01002	ARSENIC	UG/L	TOTAL	1
				01012	BERYLLIUM	UG/L	TOTAL	[illegible]
				01027	CADMIUM	UG/L	TOTAL	30
				01034	CHROMIUM	UG/L	TOTAL	[illegible]
				01042	COPPER	UG/L	TOTAL	20
				71900	MERCURY	UG/L	TOTAL	[illegible]
				01051	LEAD	UG/L	TOTAL	100
				01067	NICKEL	UG/L	TOTAL	[illegible]
				01097	ANTIMONY	UG/L	TOTAL	1
				01147	SELENIUM	UG/L	TOTAL	[illegible]
				01059	THALLIUM	UG/L	TOTAL	1
				01092	ZINC	UG/L	TOTAL	40
				00720	CYANIDE	MG/L	TOTAL	0.01[illegible]
[illegible]P.RUN	87/10/09	1021						
[illegible]THE 3000 SUBSTRATE: AQUEOUS								
[illegible]CRIPTION: RODRIGUEZ AUTO PARTS WELL # 3								
			091302	01077	SILVER	UG/L	TOTAL	20
				01002	ARSENIC	UG/L	TOTAL	1
				01012	BERYLLIUM	UG/L	TOTAL	1
				01027	CADMIUM	UG/L	TOTAL	5
				01034	CHROMIUM	UG/L	TOTAL	5
				01042	COPPER	UG/L	TOTAL	5
				71900	MERCURY	UG/L	TOTAL	.2
				01051	LEAD	UG/L	TOTAL	30
				01067	NICKEL	UG/L	TOTAL	20
				01097	ANTIMONY	UG/L	TOTAL	1
				01147	SELENIUM	UG/L	TOTAL	1
				01059	THALLIUM	UG/L	TOTAL	1
				01092	ZINC	UG/L	TOTAL	[illegible]
				00720	CYANIDE	MG/L	TOTAL	0.01[illegible]
[illegible]P.RUN	87/10/09	1132						
[illegible]THE 3000 SUBSTRATE: AQUEOUS								
[illegible]SCRIPTION: RAMSEY MOTORS WELL LOCATED NEAR AUTO REPAIR WORKS								
			09130[illegible]	01077	SILVER	UG/L	TOTAL	[illegible]
				01002	ARSENIC	UG/L	TOTAL	1
				01012	BERYLLIUM	UG/L	TOTAL	1

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COMPLETED ANALYSIS REPORT

REPORT DATE: 87/11/[illegible]

PROJECT NO: 233 PROJECT NAME: TURPENTINE RUN

STATION NO	DATE FROM TO	TIME OR DAY	LABNO	PARNO	PARAMETER NAME	UNITS	CHEMISTRY	VALUE	R	REMARK
			091305	71900	MERCURY	UG/L	TOTAL	.2		
				01051	LEAD	UG/L	TOTAL	30		
				01067	NICKEL	UG/L	TOTAL	[illegible]		
				01097	ANTIMONY	UG/L	TOTAL	1		
				01147	SELENIUM	UG/L	TOTAL	[illegible]		
				01059	THALLIUM	UG/L	TOTAL	1		
				01092	ZINC	UG/L	TOTAL	340		
				00720	CYANIDE	MG/L	TOTAL	0.017		

[illegible]RUN 87/10/05 1445

[illegible]: 0000 SUBSTRATE: AQUEOUS

[illegible]PTION: MATHIAS WELL PUMP NOT OPERATING

LABNO	PARNO	PARAMETER NAME	UNITS	CHEMISTRY	VALUE
091306	01077	SILVER	UG/L	TOTAL	20
	01002	ARSENIC	UG/L	TOTAL	1
	01012	BERYLLIUM	UG/L	TOTAL	[illegible]
	01027	CADMIUM	UG/L	TOTAL	5
	01034	CHROMIUM	UG/L	TOTAL	5
	01042	COPPER	UG/L	TOTAL	9
	71900	MERCURY	UG/L	TOTAL	.2
	01051	LEAD	UG/L	TOTAL	30
	01067	NICKEL	UG/L	TOTAL	20
	01097	ANTIMONY	UG/L	TOTAL	1
	01147	SELENIUM	UG/L	TOTAL	5.6
	01059	THALLIUM	UG/L	TOTAL	1
	01092	ZINC	UG/L	TOTAL	10
	00720	CYANIDE	MG/L	TOTAL	0.017

[illegible]UN 87/10/06 1600

[illegible] 0000 SUBSTRATE: AQUEOUS

[illegible]PTION: SMITH

LABNO	PARNO	PARAMETER NAME	UNITS	CHEMISTRY	VALUE
091307	01077	SILVER	UG/L	TOTAL	20
	01002	ARSENIC	UG/L	TOTAL	1
	01012	BERYLLIUM	UG/L	TOTAL	1
	01027	CADMIUM	UG/L	TOTAL	5
	01034	CHROMIUM	UG/L	TOTAL	5
	01042	COPPER	UG/L	TOTAL	7
	71900	MERCURY	UG/L	TOTAL	.2
	01051	LEAD	UG/L	TOTAL	30
	01067	NICKEL	UG/L	TOTAL	20

COMPLETED ANALYSIS REPORT | REPORT DATE: 87/11/2[illegible]

PROJECT NO: 2[illegible]3 | PROJECT NAME: TURPENTINE RUN

[illegible]TION NO	DATE FROM TO	TIME OF DAY	LABNO	PARNO	PARAMETER NAME	UNITS	CHEMISTRY	VALUE	REMARK
			091307	01097	ANTIMONY	UG/L	TOTAL	1	[illegible]
				01147	SELENIUM	UG/L	TOTAL	3	[illegible]
				01059	THALLIUM	UG/L	TOTAL	[illegible]	[illegible]
				01092	ZINC	UG/L	TOTAL	451	
				00720	CYANIDE	MG/L	TOTAL	0.017	[illegible]

[illegible]UN 87/10/05 1645
[illegible]: 0000 SUBSTRATE: AQUEOUS
[illegible]RIPTION: VEVCON WELL #1

			091308	01077	SILVER	UG/L	TOTAL	[illegible]	[illegible]
				01002	ARSENIC	UG/L	TOTAL	[illegible]	
				01012	BERYLLIUM	UG/L	TOTAL	[illegible]	[illegible]
				01027	CADMIUM	UG/L	TOTAL	[illegible]	[illegible]
				01034	CHROMIUM	UG/L	TOTAL	5	[illegible]
				01042	COPPER	UG/L	TOTAL	[illegible]	[illegible]
				71900	MERCURY	UG/L	TOTAL	.2	[illegible]
				01051	LEAD	UG/L	TOTAL	[illegible]	[illegible]
				01067	NICKEL	UG/L	TOTAL	[illegible]	[illegible]
				01097	ANTIMONY	UG/L	TOTAL	1	[illegible]
				01147	SELENIUM	UG/L	TOTAL	1	[illegible]
				01059	THALLIUM	UG/L	TOTAL	[illegible]	[illegible]
				01092	ZINC	UG/L	TOTAL	10	[illegible]
				00720	CYANIDE	MG/L	TOTAL	0.017	[illegible]

[illegible]UN 87/10/05 1715
[illegible] 0000 SUBSTRATE: AQUEOUS
[illegible]PTION: VEVCON WELL #3 WATER FROM SPIGOT
VERY AERATED

			091309	01077	SILVER	UG/L	TOTAL	[illegible]	[illegible]
				01002	ARSENIC	UG/L	TOTAL	[illegible]	[illegible]
				01012	BERYLLIUM	UG/L	TOTAL	1	[illegible]
				01027	CADMIUM	UG/L	TOTAL	[illegible]	[illegible]
				01034	CHROMIUM	UG/L	TOTAL	[illegible]	
				01042	COPPER	UG/L	TOTAL	[illegible]	[illegible]
				71900	MERCURY	UG/L	TOTAL	[illegible]	[illegible]
				01051	LEAD	UG/L	TOTAL	[illegible]	[illegible]
				01067	NICKEL	UG/L	TOTAL	[illegible]	[illegible]
				01097	ANTIMONY	UG/L	TOTAL	1	[illegible]
				01147	SELENIUM	UG/L	TOTAL	7.[illegible]	
				01059	THALLIUM	UG/L	TOTAL	[illegible]	[illegible]

COMPLETED ANALYSIS REPORT

REPORT DATE: 87/11/

PROJECT NO: 283 PROJECT NAME: TURPENTINE RUN

[ST]ATION NO	DATE FROM TO	TIME OF DAY	LABNO	PARNO	PARAMETER NAME	UNITS	CHEMISTRY	VALUE & REMA[RK]
			091309	01092	ZINC	UG/L	TOTAL	[illegible]
				00720	CYANIDE	MG/L	TOTAL	0.017
[TU]R.RUN	87/10/05	1920						
[ME]THOD CODE: 3703 SUBSTRATE: AQUEOUS								
[DES]CRIPTION: ALPHA LEONARD WELL HEAD								
			091310	01077	SILVER	UG/L	TOTAL	20
				01002	ARSENIC	UG/L	TOTAL	[illegible]
				01012	BERYLLIUM	UG/L	TOTAL	[illegible]
				01027	CADMIUM	UG/L	TOTAL	5
				01034	CHROMIUM	UG/L	TOTAL	[illegible]
				01042	COPPER	UG/L	TOTAL	[illegible]
				71900	MERCURY	UG/L	TOTAL	[illegible]
				01051	LEAD	UG/L	TOTAL	30
				01067	NICKEL	UG/L	TOTAL	[illegible]
				01097	ANTIMONY	UG/L	TOTAL	[illegible]
				01147	SELENIUM	UG/L	TOTAL	3.[illegible]
				01059	THALLIUM	UG/L	TOTAL	[illegible]
				01092	ZINC	UG/L	TOTAL	12
				00720	CYANIDE	MG/L	TOTAL	0.017
[TU]R.RUN	87/10/07	0959						
[ME]THOD CODE: 3703 SUBSTRATE: AQUEOUS								
[DES]CRIPTION: TRANSPORT BLANK FROM RO UNIT								
			091311	01077	SILVER	UG/L	TOTAL	20
				01002	ARSENIC	UG/L	TOTAL	1
				01012	BERYLLIUM	UG/L	TOTAL	[illegible]
				01027	CADMIUM	UG/L	TOTAL	5
				01034	CHROMIUM	UG/L	TOTAL	[illegible]
				01042	COPPER	UG/L	TOTAL	[illegible]
				71900	MERCURY	UG/L	TOTAL	[illegible]
				01051	LEAD	UG/L	TOTAL	[illegible]
				01067	NICKEL	UG/L	TOTAL	[illegible]
				01097	ANTIMONY	UG/L	TOTAL	[illegible]
				01147	SELENIUM	UG/L	TOTAL	[illegible]
				01059	THALLIUM	UG/L	TOTAL	[illegible]
				01092	ZINC	UG/L	TOTAL	[illegible]
				00720	CYANIDE	MG/L	TOTAL	0.017

COMPLETED ANALYSIS REPORT　　　REPORT DATE: 87/1[illegible]

PROJECT NO: 263　　　PROJECT NAME: TURPENTINE RUN

STATION NO	DATE FROM TO	TIME OF DAY	LABNO	PARNO	PARAMETER NAME	UNITS	CHEMISTRY	VALUE	REM
TP.RUN	87/10/07	0955							

STATION CODE: 3700　SUBSTRATE: AQUEOUS
DESCRIPTION: HARTHMANN　CRUSHER WELL

LABNO	PARNO	PARAMETER NAME	UNITS	CHEMISTRY	VALUE
091312	01077	SILVER	UG/L	TOTAL	23
	01002	ARSENIC	UG/L	TOTAL	15
	01012	BERYLLIUM	UG/L	TOTAL	1
	01027	CADMIUM	UG/L	TOTAL	5
	01034	CHROMIUM	UG/L	TOTAL	[illegible]
	01042	COPPER	UG/L	TOTAL	[illegible]
	71900	MERCURY	UG/L	TOTAL	[illegible]
	01051	LEAD	UG/L	TOTAL	[illegible]
	01067	NICKEL	UG/L	TOTAL	[illegible]
	01097	ANTIMONY	UG/L	TOTAL	[illegible]
	01147	SELENIUM	UG/L	TOTAL	[illegible]
	01059	THALLIUM	UG/L	TOTAL	[illegible]
	01092	ZINC	UG/L	TOTAL	13
	00720	CYANIDE	MG/L	TOTAL	0.017

TP.RUN　87/10/07　1130
STATION CODE: 3700　SUBSTRATE: AQUEOUS
DESCRIPTION: DEDE　WELL

LABNO	PARNO	PARAMETER NAME	UNITS	CHEMISTRY	VALUE
091313	01077	SILVER	UG/L	TOTAL	23
	01002	ARSENIC	UG/L	TOTAL	1
	01012	BERYLLIUM	UG/L	TOTAL	1
	01027	CADMIUM	UG/L	TOTAL	5
	01034	CHROMIUM	UG/L	TOTAL	5
	01042	COPPER	UG/L	TOTAL	13
	71900	MERCURY	UG/L	TOTAL	.2
	01051	LEAD	UG/L	TOTAL	30
	01067	NICKEL	UG/L	TOTAL	[illegible]
	01097	ANTIMONY	UG/L	TOTAL	[illegible]
	01147	SELENIUM	UG/L	TOTAL	[illegible]
	01059	THALLIUM	UG/L	TOTAL	1
	01092	ZINC	UG/L	TOTAL	23
	00720	CYANIDE	MG/L	TOTAL	0.017

TP.RUN　87/10/07　1250
STATION CODE: 3700　SUBSTRATE: AQUEOUS
DESCRIPTION: DENCH　WELL

LABNO	PARNO	PARAMETER NAME	UNITS	CHEMISTRY	VALUE
091314	01077	SILVER	UG/L	TOTAL	[illegible]
	01002	ARSENIC	UG/L	TOTAL	[illegible]
	01012	BERYLLIUM	UG/L	TOTAL	[illegible]

COMPLETED ANALYSIS REPORT REPORT DATE: 87/11/23

PROJECT NO: 253 PROJECT NAME: TURPENTINE RUN

DATE FROM TO	TIME OF DAY	LABNO	PARNO	PARAMETER NAME	UNITS	CHEMISTRY	VALUE	REMARK
		091314	01027	CADMIUM	UG/L	TOTAL	5	U
			01034	CHROMIUM	UG/L	TOTAL	5	U
			01042	COPPER	UG/L	TOTAL	10	U
			71900	MERCURY	UG/L	TOTAL	.2	U
			01051	LEAD	UG/L	TOTAL	10	U
			01067	NICKEL	UG/L	TOTAL	20	U
			01097	ANTIMONY	UG/L	TOTAL	4	U
			01147	SELENIUM	UG/L	TOTAL	1	U
			01059	THALLIUM	UG/L	TOTAL	10	
			01092	ZINC	UG/L	TOTAL	68	
			00720	CYANIDE	MG/L	TOTAL	0.017	U

87/10/08 1200
CODE: 0700 SUBSTRATE: AQUEOUS
DNS HARTMAN BAKERY WELL

DATE FROM TO	TIME OF DAY	LABNO	PARNO	PARAMETER NAME	UNITS	CHEMISTRY	VALUE	REMARK
		091315	01077	SILVER	UG/L	TOTAL	20	U
			01002	ARSENIC	UG/L	TOTAL	1	U
			01012	BERYLLIUM	UG/L	TOTAL	1	U
			01027	CADMIUM	UG/L	TOTAL	5	U
			01034	CHROMIUM	UG/L	TOTAL	5	U
			01042	COPPER	UG/L	TOTAL	6	U
			71900	MERCURY	UG/L	TOTAL	.2	U
			01051	LEAD	UG/L	TOTAL	30	U
			01067	NICKEL	UG/L	TOTAL	20	U
			01097	ANTIMONY	UG/L	TOTAL	1	U
			01147	SELENIUM	UG/L	TOTAL	1	U
			01059	THALLIUM	UG/L	TOTAL	1	U
			01092	ZINC	UG/L	TOTAL	20	U
			00720	CYANIDE	MG/L	TOTAL	0.017	U

***** END OF PROJECT *****

TABLE 8. TUTU WELL SITE, MONTHLY SAMPLING SUMMARY

EGLIN #2	JUL	AUG	SEP	OCT	NOV	DEC	JAN
BEN	3.1	0.0	0.0	0.0	0.0	0.0	NA
TOL	5.9	0.0	5.0	0.0	0.0	0.0	NA
PCE	57.6	43.0	40.0	62.0	22.0	8.6	NA
TCE	16.5	13.0	10.0	21.8	12.0	5.8	NA
DCE	0.0	74.0	5.0	4.5	2.0	1.4	NA

EGLIN #3	JUL	AUG	SEP	OCT	NOV	DEC	JAN
BEN		0.0	0.0	0.0	0.0	0.0	NA
TOL		0.0	1.0	0.0	0.0	0.0	NA
PCE		57.0	105.0	104.0	55.0	24.0	NA
TCE		16.0	20.0	30.5	20.0	9.2	NA
DCE		66.0	5.0	7.5	1.0	1.7	NA

SMITH	JUL	AUG	SEP	OCT	NOV	DEC	JAN
BEN		0.0	0.0	0.0	0.0	0.0	0.0
TOL		1.0	0.0	0.0	0.0	0.0	0.0
PCE		120.0	135.0	500.0	50.0	9.6	50.0
TCE		17.0	10.0	70.0	3.0	1.4	5.0
DCE		81.0	5.0	3.6	1.0	ND	NA

TILLET	JUL	AUG	SEP	OCT	NOV	DEC	JAN
BEN	6950.0	1400.0	250.0	46.0	1000.0	500.0	NA
TOL	492.0	33.0	0.0	0.0	30.0	180.0	NA
PCE	2040.0	120.0	475.0	500.0	350.0	85.0	NA
TCE	711.0	36.0	75.0	110.0	200.0	0.0	NA
DCE	327.0	620.0	10.0	19.0	45.0	0.0	NA

`4 WINDS	JUL	AUG	SEP	OCT	NOV	DEC	JAN
BEN	6.7	2.0	0.0	0.0	0.0	1.0	0.0
TOL	5.9	1.0	2.0	0.0	0.0	0.0	0.0
PCE	64.2	72.0	125.0	202.0	104.0	50.0	450.0
TCE	18.8	21.0	15.0	75.0	34.0	22.2	100.0
DCE	0.0	213.0	5.0	13.0	4.0	2.8	NA

STEELE	JUL	AUG	SEP	OCT	NOV	DEC	JAN
BEN		0.0	0.0	0.0	0.0	0.0	0.0
TOL		0.0	0.0	0.0	0.0	0.0	0.0
PCE		270.0	575.0	500.0	300.0	130.0	500.0
TCE		20.0	9.0	27.0	12.0	14.6	100.0
DCE		61.0	5.0	1.8	1.0	0.8	NA

HARVEY	JUL	AUG	SEP	OCT	NOV	DEC	JAN
BEN		0.0	0.0	0.0	0.0	0.0	0.0
TOL		1.0	0.0	0.0	0.0	0.0	0.0
PCE		7600.0	1000.0	500.0	1000.0	500.0	500.0
TCE		61.0	25.0	20.0	40.0	50.0	90.0
DCE		56.0	5.0	14.0	1.0	0.0	NA

CONCENTRATIONS IN PPB

TABLE 8. TUTU WELL SITE, MONTHLY SAMPLING SUMMARY

DEMITRIS	JUL	AUG	SEP	OCT	NOV	DEC	JAN
BEN		0.0	0.0	1.0	0.0	0.0	0.0
TOL		0.0	0.0	0.0	0.0	0.0	3.0
PCE		2.0	0.0	1.0	0.0	0.0	0.0
TCE		0.0	0.0	1.0	0.0	0.0	0.0
DCE		0.0	0.0	1.0	0.0	0.0	NA

DEDE	JUL	AUG	SEP	OCT	NOV	DEC	JAN
BEN		0.0	0.0	0.0	0.0	0.0	0.0
TOL		0.0	0.0	0.0	0.0	0.0	0.0
PCE		0.0	0.0	0.0	0.0	0.0	0.0
TCE		0.0	0.0	0.0	0.0	0.0	0.0
DCE		0.0	0.0	1.0	0.0	0.0	NA

DEVCON #1	JUL	AUG	SEP	OCT	NOV	DEC	JAN
BEN		0.0	0.0	0.0	0.0	0.0	0.0
TOL		0.0	0.0	0.0	0.0	0.0	0.0
PCE		0.0	0.0	0.0	0.0	0.0	0.0
TCE		0.0	0.0	0.0	1.0	0.0	0.0
DCE		0.0	0.0	1.0	1.0	0.0	NA

DEVCON #3	JUL	AUG	SEP	OCT	NOV	DEC	JAN
BEN		0.0	0.0	0.0	0.0	0.0	0.0
TOL		0.0	0.0	0.0	0.0	0.0	0.0
PCE		0.0	0.0	0.0	0.0	0.0	0.0
TCE		0.0	0.0	0.0	0.0	0.0	0.0
DCE		0.0	0.0	1.0	0.0	0.0	NA

VIHA #1	JUL	AUG	SEP	OCT	NOV	DEC	JAN
BEN	15.3	0.0	0.0	0.0	0.0	0.0	0.0
TOL	6.0	1.0	0.0	0.0	0.0	0.0	0.0
PCE	35.7	10.0	14.0	8.0	2.0	1.0	3.0
TCE	9.4	3.0	1.0	0.0	1.0	0.0	0.0
DCE	0.0	12.0	0.0	2.3	0.0	0.0	NA

VIHA #3	JUL	AUG	SEP	OCT	NOV	DEC	JAN
BEN		0.0	0.0	1.0	0.0	0.0	0.0
TOL		0.0	0.0	0.0	0.0	2.5	0.0
PCE		0.0	0.0	1.0	0.0	0.0	0.0
TCE		0.0	1.0	1.0	1.0	0.0	0.0
DCE		7.0	0.0	1.0	0.0	0.0	NA

EGLIN #1	JUL	AUG	SEP	OCT	NOV	DEC	JAN
BEN		0.0	0.0	0.0	0.0	2.0	NA
TOL		0.0	1.0	0.0	0.0	6.0	NA
PCE		38.0	60.0	104.0	25.0	14.0	NA
TCE		11.0	10.0	26.0	10.0	8.0	NA
DCE		63.0	5.0	4.5	2.0	1.3	NA

CONCENTRATIONS IN PPB

TABLE 8. TUTU WELL SITE, MONTHLY SAMPLING SUMMARY

DENCH	JUL	AUG	SEP	OCT	NOV	DEC	JAN
BEN		0.0	0.0	0.0	0.0	0.0	0.0
TOL		0.0	0.0	0.0	0.0	0.0	0.0
PCE		0.0	0.0	0.0	0.0	0.0	0.0
TCE		0.0	0.0	0.0	0.0	0.0	0.0
DCE		0.0	0.0	1.0	0.0	0.0	NA

RAMSEY	JUL	AUG	SEP	OCT	NOV	DEC	JAN
BEN		0.0	0.0	4.5	0.0	0.0	0.0
TOL		0.0	0.0	0.0	0.0	0.0	0.0
PCE		7.0	7.5	50.0	16.0	4.0	6.0
TCE		0.0	1.0	0.0	1.0	0.0	1.0
DCE		1.0	0.0	2.7	0.0	0.0	NA

H.CRUSHER	JUL	AUG	SEP	OCT	NOV	DEC	JAN
BEN	0.0	0.0	0.0	5.0	0.0	0.0	0.0
TOL	5.7	0.0	0.0	0.0	0.0	0.0	0.0
PCE	102.0	26.0	14.0	29.5	5.0	0.0	4.0
TCE	7.0	3.0	1.0	0.0	7.0	0.0	1.0
DCE	0.0	12.0	1.0	4.0	0.0	0.0	NA

H.BAKERY	JUL	AUG	SEP	OCT	NOV	DEC	JAN
BEN	0.0	0.0	0.0	1.0	0.0	0.0	0.0
TOL	6.3	0.0	0.0	0.0	0.0	0.0	0.0
PCE	2.9	3.0	1.0	0.0	0.0	0.0	0.0
TCE	0.0	0.0	1.0	1.0	1.0	0.0	0.0
DCE	0.0	1.0	0.0	1.0	0.0	0.0	NA

H.ESTATE	JUL	AUG	SEP	OCT	NOV	DEC	JAN
BEN		0.0	0.0	0.0	na	0.0	0.0
TOL		0.0	0.0	1.0	na	0.0	0.0
PCE		1.0	0.0	2.5	na	0.0	0.0
TCE		0.0	0.0	0.0	na	0.0	0.0
DCE		0.0	0.0	0.0	na	0.0	NA

LEONARD	JUL	AUG	SEP	OCT	NOV	DEC	JAN
BEN		0.0	0.0	0.0	0.0	0.0	0.0
TOL		0.0	0.0	0.0	0.0	0.0	0.0
PCE		1.0	0.0	0.0	0.0	0.0	0.0
TCE		0.0	0.0	0.0	0.0	0.0	0.0
DCE		0.0	0.0	0.0	0.0	0.0	NA

FRANCOIS	JUL	AUG	SEP	OCT	NOV	DEC	JAN
BEN		0.0	0.0	0.0	0.0	0.0	0.0
TOL		0.0	0.0	0.0	0.0	0.0	0.0
PCE		120.0	135.0	500.0	80.0	25.0	275.0
TCE		28.0	10.0	70.0	20.0	7.0	100.0
DCE		140.0	5.0	3.6	2.0	1.0	NA

CONCENTRATIONS IN PPB

TABLE 8. TUTU WELL SITE, MONTHLY SAMPLING SUMMARY

RODRIGUEZ	JUL	AUG	SEP	OCT	NOV	DEC	JAN
BEN		0.0	0.0	0.0	0.0	0.0	0.0
TOL		0.0	0.0	0.0	0.0	0.0	0.0
PCE		1.0	0.0	0.0	0.0	0.0	0.0
TCE		0.0	0.0	0.0	1.0	0.0	0.0
DCE		0.0	0.0	0.0	0.0	0.0	NA

BRYAN	JUL	AUG	SEP	OCT	NOV	DEC	JAN
BEN		0.0	0.0	0.0	0.0	NA	0.0
TOL		0.0	0.0	0.0	0.0	NA	0.0
PCE		0.0	0.0	0.0	0.0	NA	0.0
TCE		0.0	0.0	0.0	1.0	NA	0.0
DCE		0.0	0.0	0.0	0.0	NA	NA

MATHIAS	JUL	AUG	SEP	OCT	NOV	DEC	JAN
BEN		0.0	0.0	0.0	0.0	0.0	0.0
TOL		1.0	0.0	0.0	0.0	0.0	0.0
PCE		66.0	118.0	17.8	88.0	35.0	100.0
TCE		4.0	3.0	0.0	14.0	2.8	55.0
DCE		9.0	1.0	1.0	2.0	9.0	NA

APPENDIX D

GCL

FINAL
REPORT ON RESULTS OF SOIL GAS SURVEY, TUTU, ST. THOMAS, U. S. VIRGIN ISLANDS

December 18, 1987
Revised January 25, 1988

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1.0 EXECUTIVE SUMMARY

During November 1987, Geoscience Consultants, Ltd. (GCL) conducted a soil gas investigation in the vicinity of the Tutu service station of Texaco Caribbean, Inc., in St. Thomas, U. S. Virgin Islands. The survey results show a zone of significantly elevated total hydrocarbon concentrations (up to 690,000 micrograms per liter [ug/l] as benzene) in soil gas beneath the southwestern part of the service station site and beneath adjacent roadways west and south of the station. These values indicate the presence of hydrocarbons within the unsaturated soil zone. Another zone of moderately high soil gas total hydrocarbon values (up to 2,600 ug/l) was found 300 to 800 feet southwest of the station, within a topographic low beneath the southern part of the Four Winds Shopping Center parking lot. Moderately elevated total hydro-carbon values (up to 3,000 ug/l) were also found adjacent to an Esso service station near the southern end of the Four Winds Shopping Center parking lot. Soil gas hydrocarbons in these areas are probably a result of vaporization from hydrocarbons present in ground water.

A topographically high area around Tillett Gardens, an area of small shops, in which a relatively great depth to ground water (about 25 feet) and shallow depth to bedrock (about 5 feet) prevented adequate soil gas analysis, lies between the two mapped zones of elevated hydrocarbon values. Based on the soil gas analysis alone, it is therefore impossible to determine with certainty whether the two zones are parts of a single hydrocarbon plume or constitute two separate plumes. The presence of benzene, toluene and other hydrocarbons in the Tillett water well, which is located between the two zones, indicates that these compounds are present in ground water in at least part of the area where soil gas mapping was not feasible.

GCL also performed analyses for chlorinated compounds in soil gas at selected points in the vicinity of the Tutu service station and Tillett Gardens. Measurable concentrations of tetrachloroethylene (PCE) were found at all points sampled for chlorinated compounds, with the highest concentrations in soil gas near the LAGA building northeast of the Tutu service station. The LAGA building, where PCE is known to have been used extensively in the past, is a possible source of the chlorinated hydrocarbons.

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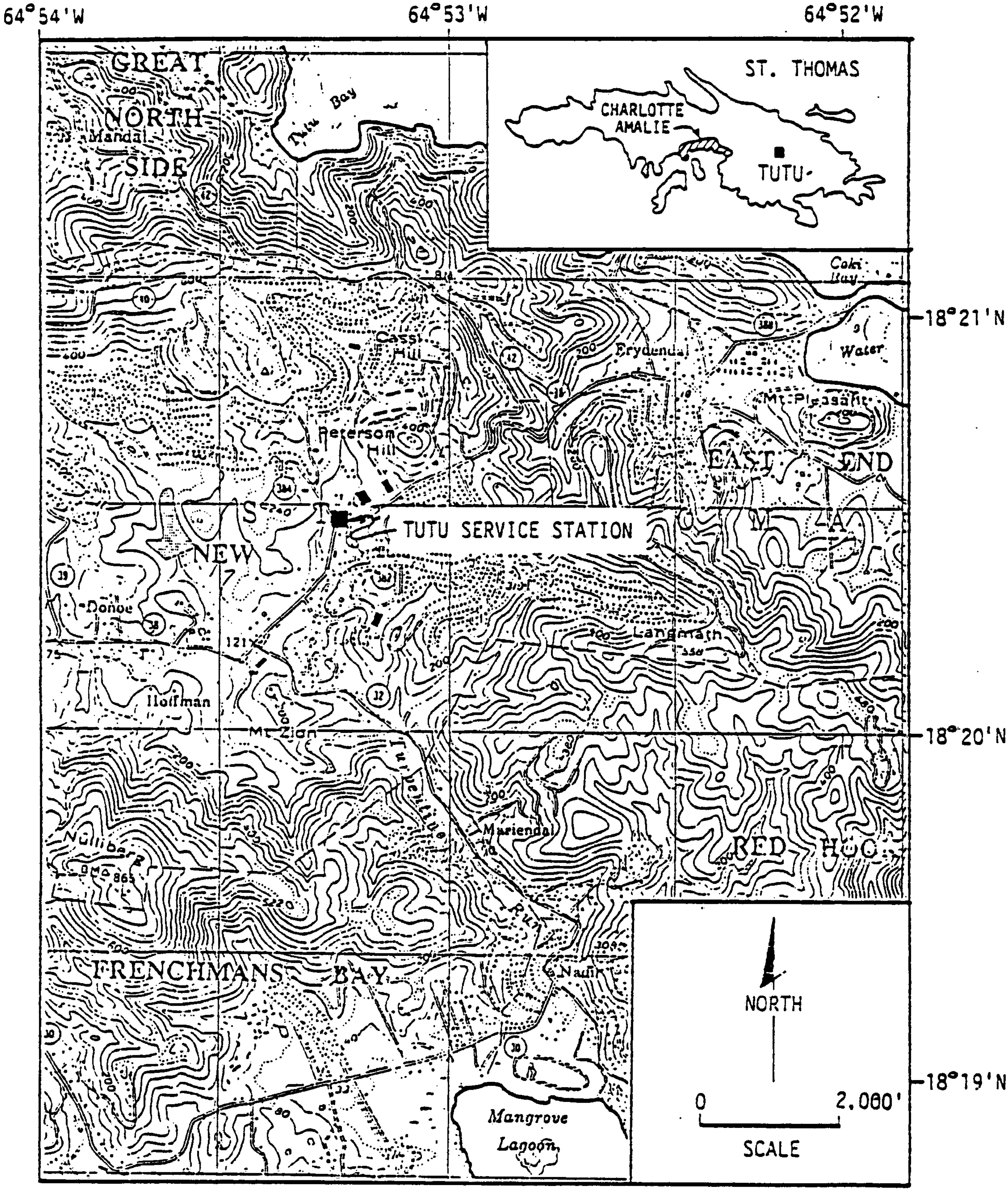
2.0 LOCATION AND HYDROGEOLOGIC BACKGROUND

2.1 LOCATION AND PURPOSE OF STUDY

During November 1987, Geoscience Consultants LTD. (GCL) conducted a soil gas survey in the vicinity of the Tutu service station of Texaco Caribbean, Inc. The purpose of the survey was to determine the range and spatial distribution of hydrocarbons present in the soil gas at the service station site, and to map the approximate extent of any hydrocarbon plume that might be encountered during the survey.

The Tutu service station is located at 18°20'31" North, 64°53'14" West, in Anna's Retreat Estate, St. Thomas, U. S. Virgin Islands (Figure 2-1). The station is on the northeast corner of the intersection of Highway 38 and Highway 384, on the eastern slope of the upper Turpentine Run basin. Nearby facilities include an auto parts store and garage north of the station, a fire station and the LAGA building (formerly a cloth manufacturing plant, now a public schools maintenance facility) uphill to the northeast of the station, and Tillett Gardens, a courtyard of small shops and a restaurant, south of the station (Figure 2-2). The Four Winds Shopping Center lies in a topographically low area along the axis of the upper Turpentine Run basin, west of the Tutu service station and Tillett Gardens.

Elevated concentrations of hydrocarbons, including benzene, toluene, and several chlorinated compounds, have been detected in water wells in the upper Turpentine Run basin (Geraghty and Miller, 1983, p. 73-74). The highest reported concentrations of benzene and toluene have been found in water from the Tillett well, located 250 feet south of the Texaco station and 300 feet northeast of an Esso service station (Figure 2-2). In August 1987, water samples from the Tillett well contained 1300 to 1400 parts per billion (ppb) of benzene and approximately 33 to 56 ppb of toluene (C. Dolan, EPA Region II, written communication). High concentrations of tetrachloroethylene (PCE) and other chlorinated compounds have also been found in the Tillett well.



Base from USGS Eastern St.Thomas 7.5 minute quadrangle.

FIGURE 2-1

TOPOGRAPHIC MAP SHOWING LOCATION OF TUTU SERVICE STATION, ST.THOMAS.

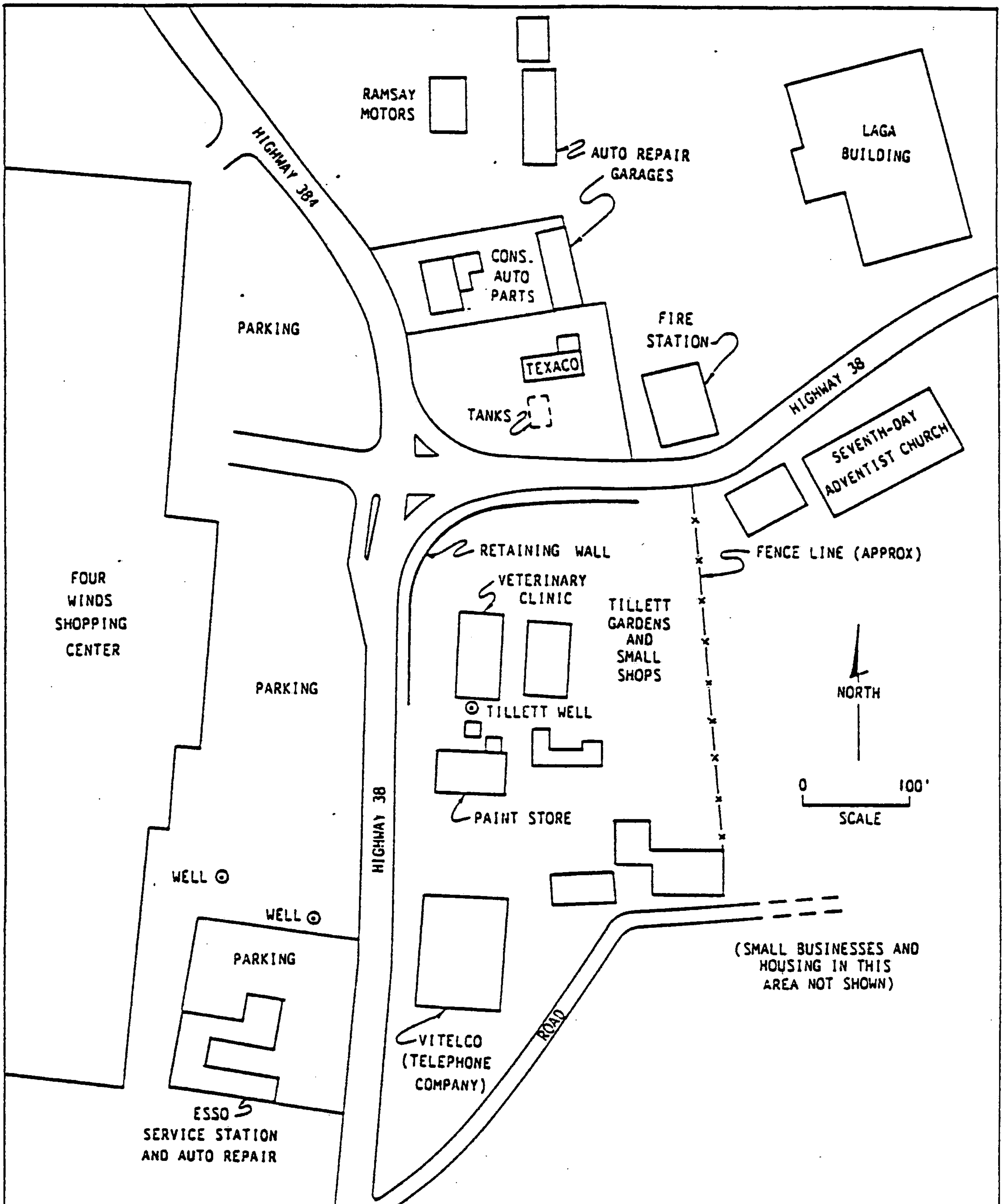


FIGURE 2-2

MAP OF CENTRAL TUTU AREA, ST.THOMAS,

SHOWING TEXACO TUTU SERVICE STATION AND NEARBY FACILITIES.

2.2 REGIONAL GEOLOGY

The lithology of the Virgin Islands consists dominantly of volcanic rocks, including spilites (albitized basalts), keratophyres (extrusive igneous rocks containing albite and mafic minerals), andesites, and volcanic breccias and conglomerates derived from the igneous rocks. The Louisenhoj Formation, which comprises the bedrock material throughout the upper Turpentine Run basin, consists dominantly of augite andesite tuff and associated volcanic breccias (Donnelly, 1966). The Louisenhoj Formation is tentatively dated as Albian (late Early Cretaceous) in age (Donnelly, 1966). The Louisenhoj Formation rocks in the vicinity of Tutu have been extensively deformed and fractured by tectonic activity during Late Cretaceous and Tertiary time.

2.3 REGIONAL HYDROLOGY

The upper Turpentine Run basin contains one of the most productive and heavily used aquifers on the island of St. Thomas. Stevens and others (1981) list 26 water wells in the Tutu area, and new wells have been completed since their report was prepared. In 1983, Geraghty and Miller estimated that "current pumpage in the upper basin may approach or exceed the estimated safe yield of 300,000 gpd [gallons per day] calculated by the USGS [U. S. Geological Survey]" (p. 68).

Ground water pumped from the upper Turpentine Run basin is derived primarily from fracture zones in the underlying Louisenhoj bedrock. To assure adequate supply, wells in the basin are commonly drilled to depths of 100 feet or more, although the water table is generally no more than 20 to 30 feet deep in the central part of the basin. Significant drawdowns occur in many wells due to pumping and seasonal water table fluctuations.

Ground water in the upper Turpentine Run basin contains total dissolved solids (TDS) of 700 to 1,800 milligrams per liter (mg/l), consisting dominantly of bicarbonate, sodium and chloride (Geraghty and Miller, 1983, p. 73, 76). Limited data from deep wells suggests that TDS concentration tends to increase with depth in the aquifer (Geraghty and

·aghty and Miller also report nitrate concentrations in (as nitrogen) from Virgin Islands Housing Authority 2, which are located approximately 800 feet northeast ·, and elevated levels of chlorinated hydrocarbons in

3.0 METHODS OF STUDY

Work performed by GCL at the Tutu service station site to date has included a preliminary site investigation, a soil gas survey, and limited hydrogeologic studies as judged appropriate for interpretation of the soil gas data. The results of the preliminary site investigation were reported in Section 3.3 of the Work Plan for Soil Gas Survey, Texaco Service Station, Tutu, St. Thomas, U. S. Virgin Islands, and were used in preparation of that work plan. The methods and results of the soil gas survey and associated hydrogeologic studies are described in this report.

3.1 SOIL GAS SURVEY

The soil gas survey at the Tutu site was conducted during November 2-18, 1987. This task consisted of soil gas sampling at points on the service station site and in nearby areas, and on-site analysis of the soil gas for selected hydrocarbons using a gas chromatograph (GC) owned and operated by Tracer Research Corporation (Tracer) of Tucson, Arizona. The gas chromatograph was equipped with detectors capable of identifying total and aromatic hydrocarbons and halogenated compounds, using flame ionization detector (FID) and electron capture detector (ECD) techniques. Soil gas sampling and analysis were performed as described in the Work Plan for Soil Gas Survey and Quality Assurance Project Plan for Soil Gas Survey dated October 1987, as approved by and with amendments requested by the U.S. Environmental Protection Agency Region II (USEPA) and the Virgin Islands Department of Planning and Natural Resources (DPNR) during discussions in the field.

The sampling and analysis were conducted in accordance with standardized procedures which have been used by GCL and Tracer at numerous sites. Soil gas samples were collected by driving a 2-cm diameter hollow galvanized steel probe to the sampling depth and evacuating 5 to 10 liters of soil gas from immediately above the drive point with a vacuum pump. A syringe was inserted through the silicone evacuation line to collect a 10-milliliter gas sample for immediate on-site analysis. Withdrawal of the sample from the evacuation line and its injection and analysis in the GC were performed by an experienced Tracer chemist.

The initial soil gas sampling grid consisted of 20 points located on the service station property, and 3 points located north and east of the station which were selected in order to define background hydrocarbon values. Samples at each point were taken from a depth of 5 feet below the ground surface and from the greatest depth achievable by hand driving of the probe, if greater than 5 feet. Samples were analyzed for total hydrocarbons, excluding methane. Since the methane peak on the chromatogram normally includes the peaks of ethane and propane as well, the resulting "total hydrocarbon" values thus include only concentrations of molecules containing 4 or more carbon atoms, which typically comprise the major constituents of commercial gasoline and similar petroleum products. Additionally, an effort was made to quantify the amounts of benzene, toluene, ethyl benzene and xylene (BTEX) in the soil gas; however, it was found that the OV-101 column employed for the FID work failed in most cases to distinguish the individual BTEX constituents. The OV-101 column has been used by GCL and Tracer in numerous soil gas investigations, and in previous cases has adequately defined all BTEX constituents.

Because a zone of high hydrocarbon values was identified in the south-western portion of the station site, the sampling grid was extended to the west and south in order to determine the extent of the hydrocarbon plume. Due to the need to avoid water lines, sewer lines, underground electrical lines, and other cultural features, the points of the extended grid were not spaced as regularly as had been anticipated in the work-plan. Probes were driven to the greatest depth attainable, which was generally about 5 feet, and a single sample was taken from the maximum depth achieved at each point. The sampling grid was extended southward and westward to the southern part of the Four Winds Shopping Center parking lot (see Section 4.1.2 of this report). Samples were analyzed for total hydrocarbons and BTEX using the OV-101 column.

During the last few days of the hydrocarbon survey, the USEPA representative at the site requested that another column be employed in an attempt to better quantify individual BTEX constituents in the soil gas. Texaco

Caribbean concurred with the request, and discussions were held with chemists from Tracer and from the EPA oversight contractor to identify an appropriate column. The Carbopak AT-1000 column, a much slower column than the OV-101, was selected.

During calibration of the system, it became apparent that the full-length AT-1000 column was unsuitable for field use because of its excessive retention time. The AT-1000 column required as much as an hour to analyze one sample, as compared with about 5 minutes for the OV-101. After a few attempts, the column was cut to a length of 1.5 feet (from its original 6-foot length), which shortened the run time to about 15 minutes, and was used to analyze a single sample taken from the vicinity of the underground storage tanks (USTs) at the Tutu service station. The column proved capable of quantifying benzene at this location, but toluene, ethyl benzene and xylene, if present, were still undeterminable due to interference by other peaks on the chromatogram. Due to the excessive run times required to obtain results that were little better than those obtained with the OV-101, no further attempts were made to use the AT-1000 column. The soil gas survey is intended as a preliminary screening tool to define the approximate extent of any hydrocarbons identified in the soil zone. The use of total hydrocarbon values is adequate to perform that task.

Although chlorinated compounds in significant quantities were considered unlikely to have resulted from activities at the Tutu service station, their presence in ground water is a matter of concern. GCL therefore conducted a limited soil gas sampling program which was intended to determine whether these compounds could have come from the Texaco station. Sampling for 6 chlorinated hydrocarbons was performed at 9 points near the Tutu station and upgradient from the Tillett water well, in which some of the compounds have been detected. Analyses were performed using the electron capture detector. The soil gas sample collection procedure was identical to that used in sampling for petroleum components.

3.2 AUXILIARY HYDROGEOLOGIC STUDIES

During the soil gas survey, GCL also conducted limited investigations into the local hydrogeologic setting in order to better define potential flow paths of hydrocarbons in the subsurface. GCL hydrogeologists measured static water level in wells close to the Tutu site, determined major fracture orientations in nearby exposures of bedrock, and recorded other topographic and geologic data relevant to potential migration pathways.

4.0 RESULTS OF SOIL GAS SURVEY

4.1 PETROLEUM HYDROCARBONS

The results of FID analyses for petroleum hydrocarbons for each soil gas point analyzed are presented in Table 4-1. Copies of all results, as recorded and supplied by the on-site chemist, are included in Appendix A of this report. Copies of chromatograms annotated by the on-site chemist will be made available, as required, in a supplement to this report.

Background concentrations were established based on analyses at three points (Background 1, Background 2, and the Drift Point) located north and northeast of the station. These points were in areas considered unlikely to be affected by any hydrocarbons which might have resulted from activities at the station. Total hydrocarbon concentrations in these locations ranged from <0.01 ug/l to 0.9 ug/l. At the Drift Point, repeat samples were taken daily by inserting separate soil gas probes within an area of less than 100 square feet, to determine whether soil gas values varied significantly over time. Daily samples taken at the Drift Point varied between 0.1 and 0.9 ug/l, with the highest value recorded at a depth of 4 feet, which was achieved on only one day. For drift samples taken at depths of 2 to 2.5 feet, total hydrocarbon concentrations varied from 0.1 to 0.4 ug/l, indicating temporal variation by up to a factor of 4 in soil gas hydrocarbon values.

The soil gas survey identified three zones in which concentrations of total hydrocarbons (excluding methane) were significantly in excess of background concentrations. These were:

- the southwestern portion of the Tutu station site and the adjacent roadways
- the southern part of the Four Winds Shopping Center parking lot
- adjacent to the Esso service station at the southern end of the Four Winds parking lot

It was not possible to verify with certainty whether these three zones in fact represent portions of the same hydrocarbon plume, or whether they

TABLE 4-1

CONCENTRATIONS OF PETROLEUM HYDROCARBONS IN SOIL GAS, TUTU AREA

(All concentration values in micrograms per liter)

LOCATION	DEPTH	DATE	BENZENE	TOLUENE	ETHYL BENZENE	XYLENES	TOTAL HYDROCARBONS (WITHOUT CH4)
Background 1	5	11/06/87	<0.01	<0.01	<0.02	<0.01	0.2
Background 2	4	11/06/87	<0.01	<0.01	<0.02	<0.01	<0.01
A-1	5	11/04/87	<230	<260	<280	<260	38,000
A-2	4.5	11/04/87	I	I	<280	<260	110,000
A-2	8.5	11/04/87	I	I	<280	<260	690,000
A-2A	4.5	11/05/87	<0.01	<0.01	<0.01	<0.01	<0.01
A-2A	7	11/05/87	I	<13	<14	<13	7,600
A-3	5	11/05/87	I	<13	<14	<13	4,600
A-3.5	5	11/05/87	I	<13	<14	<13	3,600
A-4	4.5	11/05/87	<0.01	<0.01	<0.01	<0.01	<0.01
A-4	5.5	11/05/87	I	<0.3	<0.3	<0.3	68
B-1	5	11/04/87	I	<510	<570	<530	610,000
B-2	5	11/04/87	I	I	<280	<260	280,000
B-2	8.5	11/04/87	I	I	<280	<260	220,000
B-3	5	11/04/87	I	I	<280	<260	35,000
B-3	8	11/04/87	I	I	4,000	<110	120,000
B-3.5	5	11/04/87	I	<26	<28	<27	6,400
B-4	5	11/04/87	<0.02	<0.02	<0.03	<0.03	<0.02
B-4-C	5	11/05/87	<0.01	<0.01	<0.01	<0.01	0.1
B-4-C	5	11/06/87	<0.01	<0.01	<0.02	<0.01	<0.01
B-4-C	7	11/06/87	<0.01	<0.01	<0.02	<0.01	0.5
C-1	5	11/05/87	I	<130	<130	<130	130,000
C-2	5	11/05/87	I	<130	<140	<130	72,000
C-3	5	11/05/87	I	<0.5	<0.6	<0.5	1,000
C-4	4	11/04/87	<0.09	<0.1	<0.1	<0.1	<0.09
C-4	7	11/04/87	<0.9	<1	<1	<1	1,700
D-1	4.5	11/05/87	<0.01	<0.01	<0.01	<0.01	8
D-2	2.5	11/05/87	I	<0.5	<0.6	<0.5	1,000
D-3	5	11/05/87	<0.01	<0.01	<0.01	<0.01	<0.01
D-4	4	11/04/87	<0.09	0.5	<0.1	<0.1	4
F-1	4.5	11/10/87	<0.02	<0.02	<0.03	<0.02	0.06
F-1	6	11/10/87	<0.02	<0.02	<0.03	<0.02	<0.02
F-2	4.5	11/10/87	<0.02	<0.02	<0.03	<0.02	0.07
F-3	6.5	11/10/87	<0.02	<0.02	<0.03	<0.02	0.4
F-4	6.5	11/10/87	<0.02	<0.02	<0.03	<0.02	0.2

I = interference with adjacent peaks

TABLE 4-1 (Continued)

LOCATION	DEPTH	DATE	BENZENE	TOLUENE	ETHYL BENZENE	XYLENES	TOTAL HYDROCARBONS (WITHOUT CH4)
F-4	9.5	11/10/87	<0.02	<0.02	<0.03	<0.02	0.3
F-5	5.5	11/10/87	<0.02	<0.02	<0.03	<0.02	0.2
F-6	6	11/10/87	<0.02	<0.02	<0.03	<0.02	0.4
F-7	3.5	11/11/87	<0.02	<0.03	<0.03	<0.03	10
F-8	6	11/11/87	<0.02	<0.03	<0.03	<0.03	2
F-9	2	11/12/87	<0.02	<0.02	<0.03	<0.02	6
F-10	5.5	11/12/87	I	<6	<7	<6	2,600
F-11	4	11/12/87	I	<0.5	<0.5	<0.5	120
F-12	3.5	11/12/87	0.4	<0.1	<0.1	<0.1	40
F-13	5.5	11/12/87	0.02	<0.02	<0.03	<0.02	7
F-14	2	11/12/87	I	<12	<14	<13	3,000
F-15	2.5	11/13/87	<0.02	<0.02	<0.03	<0.03	43
F-16	6	11/13/87	<0.02	<0.02	<0.03	<0.03	11
F-17	5	11/14/87	<0.02	<0.03	<0.03	<0.03	33
F-18	3.5	11/14/87	<0.02	0.07	<0.03	<0.03	0.2
F-19	5	11/14/87	I	<5	<6	<6	1,800
F-20	6	11/14/87	<0.02	<0.03	<0.03	<0.03	26
F-21	6	11/14/87	<0.02	<0.03	<0.03	<0.03	1
F-22	6	11/14/87	<0.02	<0.03	<0.03	<0.03	0.2
T-1	5	11/09/87	<0.01	<0.01	<0.01	<0.01	<0.01
T-1	7	11/09/87	<0.02	<0.02	<0.02	<0.02	<0.02
T-2	5	11/09/87	<0.02	<0.02	<0.02	<0.02	<0.02
T-2	7	11/09/87	<0.02	<0.02	<0.02	<0.02	<0.02
T-3	4	11/09/87	<0.2	<0.2	<0.3	<0.3	230
T-5	4	11/06/87	<0.01	<0.01	<0.02	<0.01	0.6
T-6	2.5	11/09/87	<0.02	<0.02	<0.02	<0.02	<0.02
T-7	5	11/09/87	<0.02	<0.02	<0.02	<0.02	<0.02
T-7	5.5	11/09/87	<0.02	<0.02	<0.02	<0.02	10
T-8	2	11/09/87	<0.02	<0.02	<0.02	<0.02	0.9
T-10	3	11/09/87	<0.02	<0.02	<0.02	<0.02	10
T-11	5	11/09/87	<0.02	<0.02	<0.02	<0.02	3
T-12	3.5	11/09/87	<0.02	<0.02	<0.02	<0.02	0.4
T-13	4.5	11/09/87	<0.02	<0.02	<0.02	<0.02	5
T-14	5.5	11/12/87	<0.02	<0.02	<0.03	<0.02	2
T-15	3.5	11/12/87	<0.02	<0.02	<0.03	<0.02	0.02

I = interference with adjacent peaks

TEXC\TABLE4-1.WK1

TABLE 4-1 (Concluded)

LOCATION	DEPTH	DATE	BENZENE	TOLUENE	ETHYL BENZENE	XYLENES	TOTAL HYDROCARBONS (WITHOUT CH4)
T-16	5.5	11/13/87	<0.02	<0.02	<0.03	<0.03	0.4
T-17	6	11/13/87	<0.02	<0.02	<0.03	<0.03	0.2
T-17	6	11/14/87	<0.02	<0.03	<0.03	<0.03	<0.02
T-18	5.5	11/13/87	<0.02	<0.02	<0.03	<0.03	0.4
T-19	6	11/13/87	<0.02	<0.02	<0.03	<0.03	0.2
T-19	10	11/13/87	<0.02	<0.02	<0.03	<0.03	2
T-20	4.5	11/14/87	<0.02	<0.03	<0.03	<0.03	0.2
Z-1	5	11/11/87	I	<7	<7	<7	4,000
Z-2	3.5	11/11/87	I	<52	<58	<54	28,000
Z-4	6	11/11/87	I	<26	<29	<26	12,000
Z-5	5	11/11/87	I	<5	<6	<5	860
Drift 1	4	11/04/87	<0.02	<0.02	<0.03	<0.03	0.9
Drift 2	2.5	11/05/87	<0.01	<0.01	<0.01	<0.01	0.1
Drift 3	2	11/06/87	<0.01	<0.01	<0.02	<0.01	0.2
Drift 4	2	11/09/87	<0.01	<0.01	<0.01	<0.01	0.2
Drift 5	2.5	11/11/87	<0.02	<0.03	<0.03	<0.03	0.4
Drift 6	2	11/12/87	<0.02	<0.02	<0.03	<0.02	0.4
Drift 6	2	11/13/87	<0.02	<0.02	<0.03	<0.03	0.2
Drift 7	2	11/14/87	<0.02	<0.03	<0.03	<0.03	0.4

I = interference with adjacent peaks

TEXC\TABLE4-1.WK1

are entirely separate, because lithologic and hydrologic conditions in the intervening area prevented adequate soil gas analysis (see Section 4.1.2).

4.1.1 Service Station Site

Soil gas hydrocarbon values measured on and immediately adjacent to the Tutu service station site are shown in Figure 4-1. In cases where a hole was sampled at two different depths, both concentration values are shown, but the value from the greater depth was used in mapping the concentration contours. In all holes except B-2, the deeper point yielded the higher value; in B-2 the values determined at 5 feet and 8.5 feet were similar.

A zone of hydrocarbon concentrations significantly higher than background levels is centered southwest of the underground storage tanks and extends southward and westward beneath the highways adjacent to the station property (Figure 4-2; Zone I, Figure 4-3). Elevated hydrocarbon concentrations were found consistently at depths of about 5 feet and at depths of about 8 feet (maximum depth of probe penetration) in the central part of this area; however, at some points along the station boundaries (A-4, A-2A, C-4) hydrocarbon concentrations appear to increase significantly with depth between 4 feet and 8 feet.

There was no evidence of significant hydrocarbon presence along the northern and eastern boundaries of the station site. The value of 1,700 ug/l recorded in hole C-4 near the north boundary of the station is probably a result of hydrocarbon vapors migrating from the adjacent oil separator pit. Movement of hydrocarbons east of the station area may be inhibited by the steep southwestward topographic and water table gradients.

4.1.2 Other Areas With Hydrocarbon Concentration Above Background Levels

An attempt was made to trace the zone of elevated hydrocarbon concentrations to the south across Highway 38 from the Tutu station. However, no

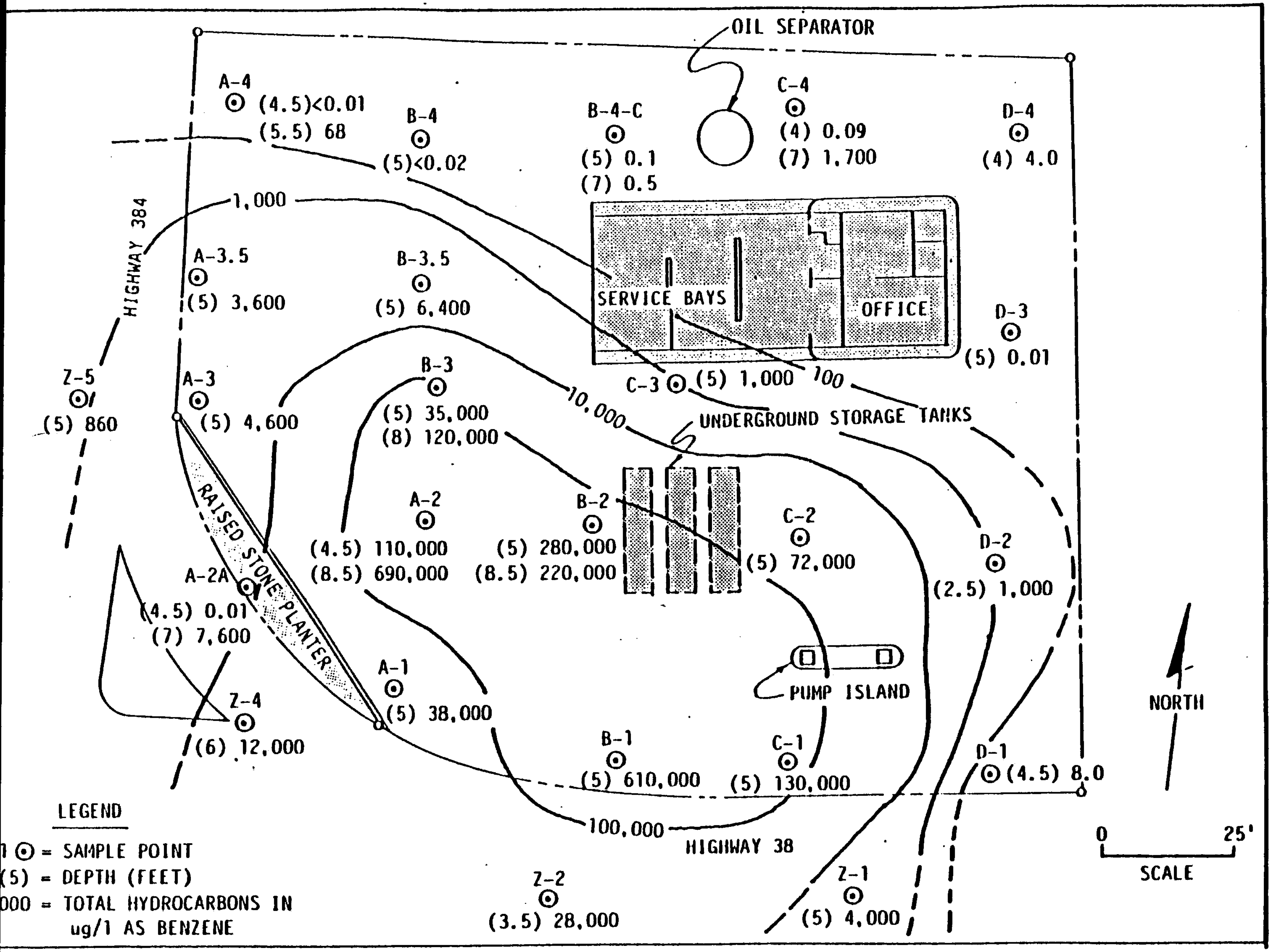


FIGURE 4-1

CONCENTRATIONS OF TOTAL PETROLEUM HYDROCARBONS IN SOIL GAS ON TUTU SERVICE STATION SITE

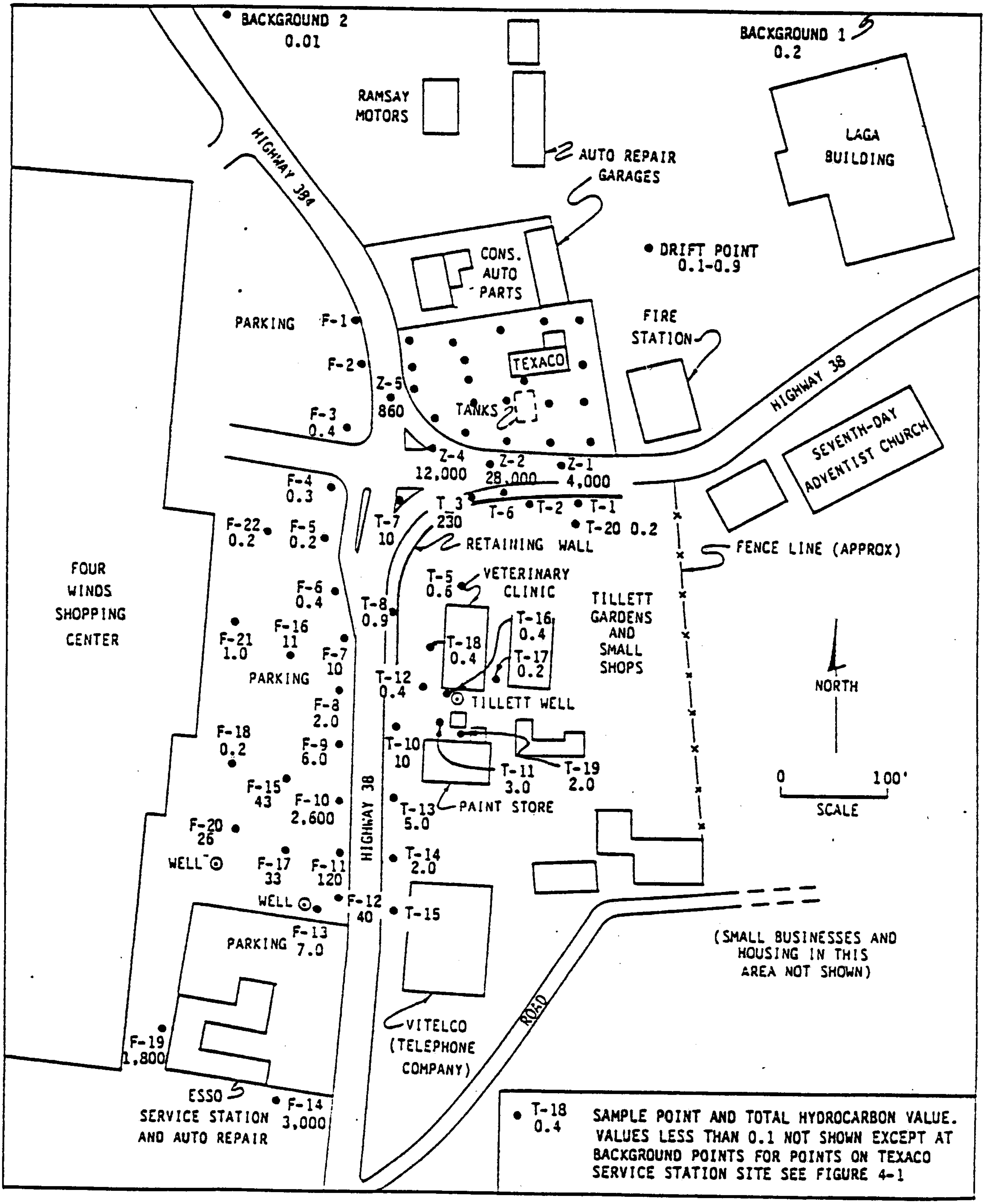


FIGURE 4-2

CONCENTRATIONS OF TOTAL PETROLEUM HYDROCARBONS IN SOIL GAS IN THE TUTU AREA, UPPER TURPENTINE RUN BASIN. ALL CONCENTRATIONS IN MICROGRAMS PER LITER, REPORTED AS BENZENE

COMPLETED ANALYSIS REPORT

REPORT DATE: 87/1[illegible]

PROJECT NO: 233

PROJECT NAME: TURPENTINE RUN

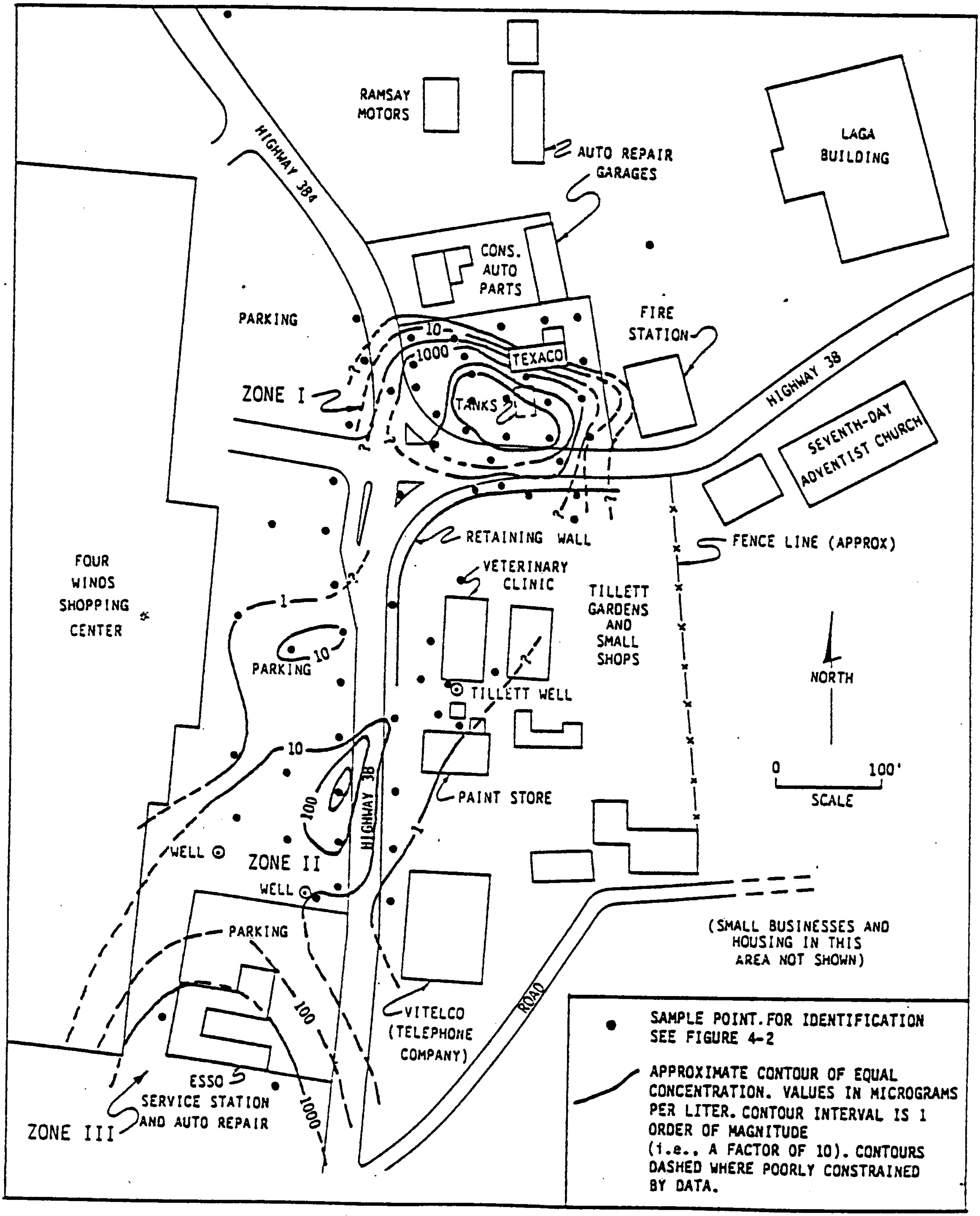
...TION NO	DATE FROM TO	TIME OF DAY	LABNO	PARNO	PARAMETER NAME	UNITS	CHEMISTRY	VALUE ...
			033780	71900	MERCURY	UG/L	TOTAL	[illegible]
				01051	LEAD	UG/L	TOTAL	30
				01067	NICKEL	UG/L	TOTAL	[illegible]
				01097	ANTIMONY	UG/L	TOTAL	1
				01147	SELENIUM	UG/L	TOTAL	[illegible]
				01059	THALLIUM	UG/L	TOTAL	3
				01092	ZINC	UG/L	TOTAL	[illegible]
				00720	CYANIDE	MG/L	TOTAL	0.014

...P. RUN 87/10/05 1525
...MS 0000 SUBSTRATE: AQUEOUS
...RIPTION: ELGIN WELL #2

033781	01077	SILVER	UG/L	TOTAL	[illegible]
	01002	ARSENIC	UG/L	TOTAL	[illegible]
	01012	BERYLLIUM	UG/L	TOTAL	[illegible]
	01027	CADMIUM	UG/L	TOTAL	5
	01034	CHROMIUM	UG/L	TOTAL	[illegible]
	01042	COPPER	UG/L	TOTAL	3
	71900	MERCURY	UG/L	TOTAL	.2
	01051	LEAD	UG/L	TOTAL	30
	01067	NICKEL	UG/L	TOTAL	20
	01097	ANTIMONY	UG/L	TOTAL	1
	01147	SELENIUM	UG/L	TOTAL	[illegible]
	01059	THALLIUM	UG/L	TOTAL	1
	01092	ZINC	UG/L	TOTAL	200
	00720	CYANIDE	MG/L	TOTAL	0.014

... RUN 87/10/05 1530
...MS 0000 SUBSTRATE: AQUEOUS
...RIPTION: ELGIN WELL #1

033782	01077	SILVER	UG/L	TOTAL	[illegible]
	01002	ARSENIC	UG/L	TOTAL	[illegible]
	01012	BERYLLIUM	UG/L	TOTAL	[illegible]
	01027	CADMIUM	UG/L	TOTAL	[illegible]
	01034	CHROMIUM	UG/L	TOTAL	[illegible]
	01042	COPPER	UG/L	TOTAL	[illegible]
	71900	MERCURY	UG/L	TOTAL	[illegible]
	01051	LEAD	UG/L	TOTAL	[illegible]
	01067	NICKEL	UG/L	TOTAL	[illegible]



GCL

FIGURE 4-3

CONTOURS OF TOTAL PETROLEUM

values of hydrocarbons in excess of background levels were detected in the area between the Tillett well and the north boundary of the Tillett property at Highway 38, except at points under the sidewalk and under a traffic island (points T-3 and T-7, Figure 4-2). Topographically, the northern part of the Tillett property, southeast of the retaining wall shown in Figure 2-2, is 10 to 15 feet higher than the land surface at the service station, and it was not possible to achieve depths greater than about 5 feet in placing the soil gas probes because of the presence of bedrock at that depth. Ground water is at a depth of about 25 to 30 feet beneath the Tillett property, and thus is 20 feet or more below the greatest depth of probe penetration. Therefore, the possible presence of petroleum hydrocarbons at depths too great to be sampled beneath the Tillett property could not be determined.

South of the Tillett well, detectable concentrations of hydrocarbons were found in the southern part of the Four Winds Shopping Center parking lot, near the Esso station and locally along the east side of Highway 38 (Zones II and III, Figure 4-3). Although most of the constituents identified appear to be petroleum components, there was some admixture of other compounds (up to about 5 ug/l as benzene in some holes) which appear to have a different origin. Since significant concentrations of halogenated compounds were found in holes near this area, it is possible that the unidentified constituents identified by the FID represent some of the halogenated compounds.

It was possible to identify and map Zones II and III southwestward to and beyond the Esso service station at the south end of the Four Winds parking lot, even though bedrock in much of the area prevented probe penetration to depths greater than about 5 feet (Figure 4-3). South and west of the Esso station, increased soil gas hydrocarbon concentrations were found, relative to those which were found immediately north of the station. The soil gas survey was terminated at this location, because of the presence of increased hydrocarbon concentrations probably attributable to a different source. Tracing of any soil gas plume not potentially attributable to the Texaco station was outside the scope of the work plan.

4.2 CHLORINATED HYDROCARBONS

Because chlorinated hydrocarbons have been identified in water samples from the Tillett well and other wells in the Tutu area, a limited number of soil gas points were sampled and analyzed for chlorinated compounds. These points were located in the vicinity of the Tillett well, on and adjacent to the Texaco service station, and near the LAGA building (Figure 4-4). Samples were analyzed for:

- methylene chloride (dichloromethane)
- chloroform (trichloromethane)
- trichloroethane (TCA)
- carbon tetrachloride (tetrachloromethane)
- trichloroethylene (TCE)
- tetrachloroethylene (PCE)

Results of the chlorinated hydrocarbon analyses are listed in Table 4-2. No significant concentration of any chlorinated compound was identified in hole H-9, located on the Texaco station, in the center of the known petroleum hydrocarbon plume. Methylene chloride (6 ug/l) was identified in soil gas beneath the property north of the Texaco service station, and TCA was identified at several locations, with the largest value (10 ug/l) being recorded in hole H-6, south of the Tillett well.

PCE was detected in all nine of the holes sampled for chlorinated compounds. The lowest PCE concentration (0.02 ug/l) was found at the Texaco station; the highest (170 ug/l) was found adjacent to the loading dock at the LAGA building. PCE was also identified at points near the Tillett well, although benzene and toluene, known to exist in the well water, had

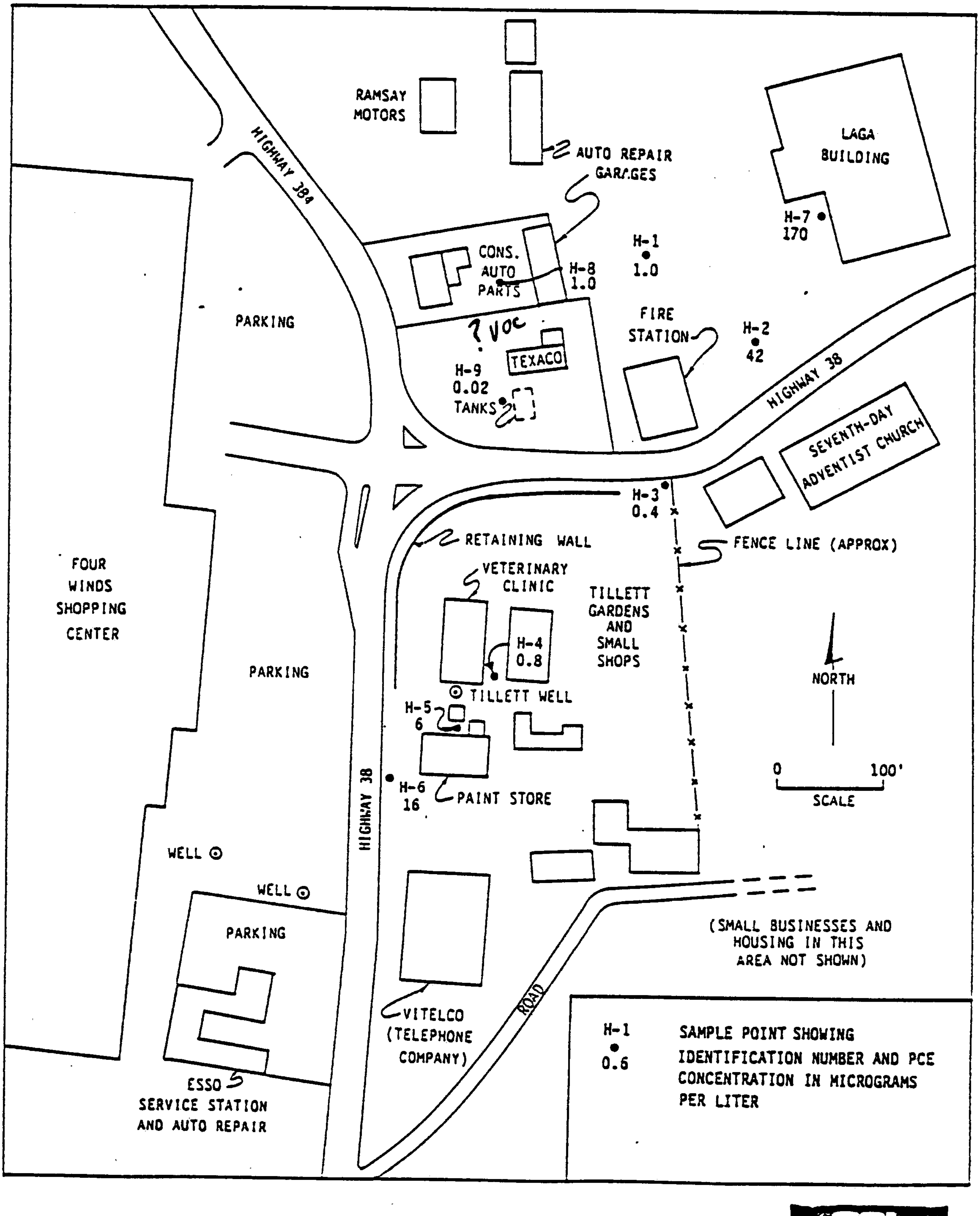

RAMSAY MOTORS
AUTO REPAIR GARAGES
LAGA BUILDING
HIGHWAY 384
H-7
170
H-1
1.0
CONS. AUTO PARTS
H-8
1.0
PARKING
? VOC
TEXACO
FIRE STATION
H-2
42
H-9
0.02
TANKS
HIGHWAY 38
SEVENTH-DAY ADVENTIST CHURCH
H-3
0.4
RETAINING WALL
FENCE LINE (APPROX)
FOUR WINDS SHOPPING CENTER
VETERINARY CLINIC
TILLETT GARDENS AND SMALL SHOPS
H-4
0.8
PARKING
NORTH
TILLETT WELL
H-5
6
0
100'
SCALE
HIGHWAY 38
H-6
16
PAINT STORE
WELL
WELL
PARKING
(SMALL BUSINESSES AND HOUSING IN THIS AREA NOT SHOWN)
ROAD
VITELCO (TELEPHONE COMPANY)
H-1
0.6
SAMPLE POINT SHOWING IDENTIFICATION NUMBER AND PCE CONCENTRATION IN MICROGRAMS PER LITER
ESSO SERVICE STATION AND AUTO REPAIR
GCL

FIGURE 4-4

TABLE 4-2

CONCENTRATIONS OF CHLORINATED HYDROCARBONS IN SOIL GAS, TUTU AREA

(All concentration values in micrograms per liter)

SAMPLE	DEPTH	DATE	METHYLENE CHLORIDE	CHLOROFORM	TCA	CARBON TETRACHLORIDE	TCE	PCE
H-1	3	11/17/87	<0.9	<0.006	0.02	<0.0005	<0.004	1
H-2	3.5	11/17/87	<0.9	<0.006	0.05	<0.0005	0.5	42
H-3	4	11/17/87	<0.09	<0.0006	<0.0002	<0.00005	<0.0004	0.4
H-4	3.5	11/17/87	<0.09	<0.0006	0.005	<0.00005	<0.0004	0.8
H-5	4	11/17/87	<0.2	<0.001	<0.0004	<0.0001	0.05	6
H-6	4.5	11/17/87	<30	<0.2	10	<0.02	<0.1	16
H-7	5	11/17/87	<0.9	<0.006	0.04	<0.0005	0.6	170
H-8	5	11/17/87	6	<0.006	<0.002	<0.0005	0.3	1
H-9	5.5	11/17/87	<0.09	<0.0006	<0.0002	<0.00005	<0.0004	0.02

TEXC\TABLE4-2.PRN

not been detectable at the same points. The greater volatility of the chlorinated compounds relative to the petroleum components explains the comparative ease with which they can be traced in soil gas, assuming both are present in ground water.

No attempt was made to delineate the boundaries of any chlorinated hydrocarbon plume, which is likely to be areally extensive. PCE has been found in water from a Virgin Islands Housing Authority well approximately 600 feet northeast of the LAGA building, as well as in the Tillett well and one of the Four Winds water wells (Geraghty and Miller, 1983, p. 74; C. Dolan, EPA Region II, written communication). A possible source of the PCE is the LAGA building, presently used as a public schools office and service facility. The LAGA building formerly housed a cloth factory, closed about 1981, in which tetrachloroethylene (also known as perchloroethylene, or "perk") is reported to have been used extensively. Unsubstantiated verbal reports of local residents indicate that the "perk" may have been disposed of to the ground surface near the building.

5.0 PROBABLE MIGRATION PATHWAYS

5.1 GROUND-WATER DATA

The water table in the upper Turpentine Run basin is generally within 30 feet or less of the ground surface, and is influenced by the local topography.

During November 1987 the static water levels were measured by GCL in the Tillett well and the eastern Four Winds well. The western Four Winds well was not measurable because it lacked an adequate port for insertion of the water level probe. Water levels were 23.2 feet below top of casing in the Tillett well, and 14.0 feet below top of casing in the eastern Four Winds well. Top of casing at the Tillett well is about 1 foot above the ground surface, while that of the Four Winds well is even with the ground surface. Taking into account the difference in well head elevations (approximately 28 feet, as measured by tape and Brunton compass), this indicates a difference of about 19 feet in water-table elevations at the two wells, and a water-table gradient of about 0.076, if the Four Winds well is assumed to be directly downgradient from the Tillett well. The gradient along the valley axis may be less than this figure, whereas that on the eastern slope may be greater. It is not known whether the Tillett and Four Winds wells intersect the same fracture zone, or zones which are hydraulically connected.

5.2 BEDROCK FRACTURE SYSTEMS

Most ground water in the upper Turpentine Run basin is contained within fracture systems of the Louisenhoj bedrock. Only minimal flow is expected in the matrix of this fine-grained volcanic unit. Observations of the soil profile, where it is exposed in road cuts and construction excavations, indicated that the zone of significant weathering extends to only about 6 feet below the surface in most areas, with fractured bedrock below that level. These observations were confirmed by the difficulty encountered in driving soil gas probes deeper than about 5 or 6 feet in most of the study area. Consequently, the direction of local ground-water flow will be strongly influenced by the orientation of the bedrock fracture systems through which the water is moving.

Bedrock fracture orientations are not consistent throughout the upper Turpentine Run basin. Orientations measured on outcrops exposed west of the Four Winds Shopping center (west side of valley) and east of the Seventh-Day Adventist Church and School (east side of valley) are shown schematically in Figure 5-1. There are major fracture systems striking north-northeast on both sides of the valley; however, those on the west side of the valley dip to the southeast, while these on the east side dip to the northwest. Consequently, these two systems differ by about 60° in actual fracture orientation. It is not known whether there is an abrupt transition along a defined boundary between these two systems at some point within the valley, or whether the orientation of the fractures rotates gradually from one position to the other as one moves across the valley.

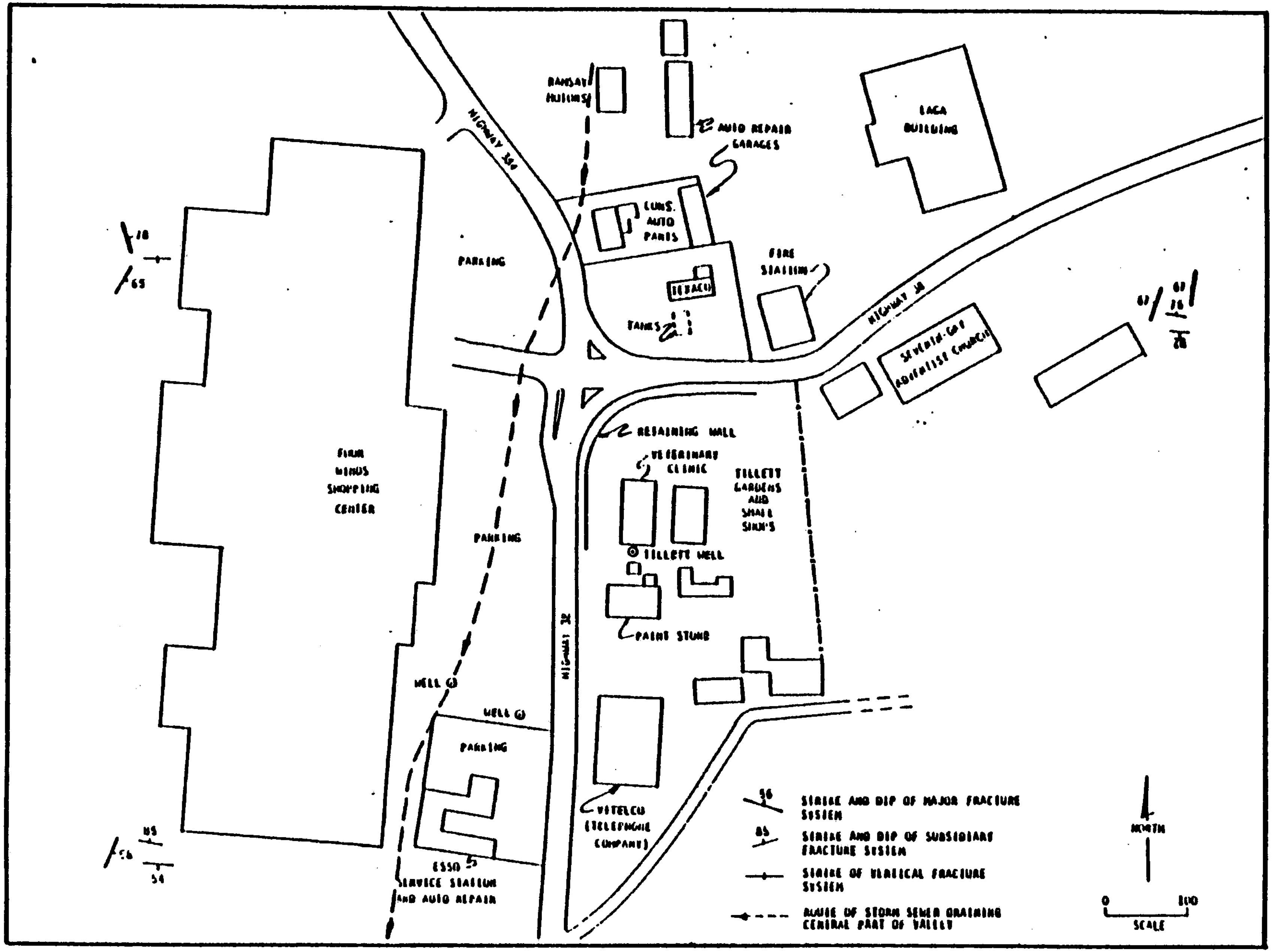


FIGURE 5-1

ORIENTATIONS OF MAJOR FRACTURE SYSTEMS

IN THE TUTU AREA, UPPER TURPENTINE RUN BASIN.

6.0 CONCLUSIONS

The soil gas survey conducted by Texaco Caribbean, Inc., and GCL in the Tutu area of St. Thomas identified a zone of elevated petroleum hydrocarbon values in the subsurface on the southwestern part of the Texaco Tutu service station site (Zone I). The very high soil gas hydrocarbon values in this area (up to 690,000 ug/l) indicate the probability that hydrocarbons have migrated through the unsaturated soil zone, leaving large residual concentrations. The source of the hydrocarbons appears to be the USTs at the Texaco station.

Elevated hydrocarbon values were traced southward to the south side of Highway 38 and westward to the center of Highway 384. Points located on the west side of Highway 384 indicate no significant hydrocarbon presence in that area. Due to elevated bedrock and greater depth to water (25 to 30 feet), it was not possible to determine the extent of petroleum hydrocarbon presence in the vicinity of the Tillett well, in which the presence of benzene and toluene has been reported in ground water. The same constraints limited complete mapping of the hydrocarbon plume on the south side of Highway 38 across from the Texaco service station.

Moderately elevated concentrations of hydrocarbons were found in soil gas beneath the southern part of the Four Winds Shopping Center parking lot (Zone II) and adjacent to the Esso station (Zone III), 300 to 800 feet downgradient from the Texaco station. The hydrocarbons encountered in soil gas in this zone are probably derived by volatilization from a plume of hydrocarbons moving with the ground water in the upper Turpentine Run aquifer. However, based on the soil gas data, it was not possible to determine with certainty whether Zones I, II and III are discontinuous or whether they in fact represent parts of a single plume. It is not possible to delineate such a plume by soil gas methods beneath the bedrock high which underlies the Tillett property. Other direct methods of sampling ground water and vadoze zone will be required to define the relationship between the two areas of elevated soil gas concentrations.

Elevated levels of PCE were found in much of the study area, and other chlorinated hydrocarbons were found in some locations. The source of these compounds appears to be northeast of the Texaco service station, and is possibly the LAGA building, where PCE is known to have been used extensively in the past.

7.0 REFERENCES CITED

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APPENDIX A

TRACER RESEARCH CORPORATION REPORT OF
ANALYTICAL RESULTS

GEOSCIENCE CONSULTANTS/TEXACO/TUTU, VIRGIN ISLANDS

Tracer Research Corporation

Sample	Depth	Date	Benzene (ug/l)	Toluene (ug/l)	Ethyl Benzene (ug/l)	Xylenes (ug/l)	Total Hydroc.w/o CH4 (ug/l)
S6-A1	5'	11/04	<230	<260	<280	<260	38,000
S6-A2	4.5'	11/04	I	I	<280	<260	110,000
S6-A2	8.5'	11/04	I	I	<280	<260	690,000
S6-A2A	4.5'	11/05	<0.01	<0.01	<0.01	<0.01	<0.01
S6-A2A	7'	11/05	I	<13	<14	<13	7,600
S6-A3	5'	11/05	I	<13	<14	<13	4,600
S6-A3.5	5'	11/05	I	<13	<14	<13	9,600
S6-A4	4.5'	11/05	<0.01	<0.01	<0.01	<0.01	<0.01
S6-A4	5.5'	11/05	I	<0.3	<0.3	<0.3	68
S6-B1	5'	11/04	I	<510	<570	<530	610,000
S6-B2	5'	11/04	I	I	<280	<260	280,000
S6-B2	8.5'	11/04	I	I	<280	<260	220,000
S6-B3	5'	11/04	I	I	<280	<260	35,000
S6-B3	8'	11/04	I	I	4,000	<110	120,000
S6-B3.5	5'	11/05	I	<26	<28	<27	6,400
S6-B4	5'	11/04	<0.02	<0.02	<0.03	<0.03	<0.02
S6-B4C	5'	11/05	<0.01	<0.01	<0.01	<0.01	0.1
S6-B4C	5'	11/06	<0.01	<0.01	<0.02	<0.01	<0.01
S6-B4C	7'	11/06	<0.01	<0.01	<0.02	<0.01	0.5
S6-BG1	5'	11/06	<0.01	<0.01	<0.02	<0.01	0.2
S6-BG2	4'	11/06	<0.01	<0.01	<0.02	<0.01	<0.01
S6-C1	5'	11/05	I	<130	<130	<130	130,000
S6-C2	5'	11/05	I	<130	<140	<130	72,000
S6-C3	5'	11/05	I	<0.5	<0.6	<0.5	1,000
S6-C4	4'	11/04	<0.09	<0.1	<0.1	<0.1	<0.09
S6-C4	7'	11/04	<0.9	<1	<1	<1	1,700
S6-D1	4.5'	11/05	<0.01	<0.01	<0.01	<0.01	8
S6-D2	2.5'	11/05	I	<0.5	<0.6	<0.5	1,000
S6-D3	5'	11/05	<0.01	<0.01	<0.01	<0.01	<0.01
S6-D4	4'	11/04	<0.09	0.5	<0.1	<0.1	4
SF-01	4.5'	11/10	<0.02	<0.02	<0.03	<0.02	0.06
SF-01	6'	11/10	<0.02	<0.02	<0.03	<0.02	<0.02
SF-02	4.5'	11/10	<0.02	<0.02	<0.03	<0.02	0.07
SF-03	6.5'	11/10	<0.02	<0.02	<0.03	<0.02	0.4
SF-04	6.5'	11/10	<0.02	<0.02	<0.03	<0.02	0.2

Notations:
I interference with adjacent peaks
NA not analyzed

Analyzed by M. Krotenberg

Checked by M. Krotenberg

EOSCIENCE CONSULTANTS/TEXACO/TUTU, VIRGIN ISLANDS

Tracer Research Corporation

ample	Depth	Date	Benzene (ug/l)	Toluene (ug/l)	Ethyl Benzene (ug/l)	Xylenes (ug/l)	Total Hydroc.w/o CH4 (ug/l)
SF-04	9.5'	11/10	<0.02	<0.02	<0.03	<0.02	0.3
SF-05	5.5'	11/10	<0.02	<0.02	<0.03	<0.02	0.2
SF-06	6'	11/10	<0.02	<0.02	<0.03	<0.02	0.4
SF-07	3.5'	11/11	<0.02	<0.03	<0.03	<0.03	10
SF-08	6'	11/11	<0.02	<0.03	<0.03	<0.03	2
SF-09	2'	11/12	<0.02	<0.02	<0.03	<0.02	6
SF-10	5.5'	11/12	1	<6	<7	<6	2,600
SF-11	4'	11/12	1	<0.5	<0.5	<0.5	120
SF-12	3.5'	11/12	0.4	<0.1	<0.1	<0.1	40
SF-13	5.5'	11/12	0.02	<0.02	<0.03	<0.02	7
SF-14	2'	11/12	1	<12	<14	<13	3,000
SF-15	2.5'	11/13	<0.02	<0.02	<0.03	<0.03	43
SF-16	6'	11/13	<0.02	<0.02	<0.03	<0.03	11
SF-17	5'	11/14	<0.02	<0.03	<0.03	<0.03	33
SF-18	3.5'	11/14	<0.02	0.07	<0.03	<0.03	0.2
SF-19	5'	11/14	1	<5	<6	<6	1,800
SF-20	6'	11/14	<0.02	<0.03	<0.03	<0.03	26
SF-21	6'	11/14	<0.02	<0.03	<0.03	<0.03	1
SF-22	6'	11/14	<0.02	<0.03	<0.03	<0.03	0.2
ST-01	5'	11/09	<0.01	<0.01	<0.01	<0.01	<0.01
ST-01	7'	11/09	<0.02	<0.02	<0.02	<0.02	<0.02
ST-02	5'	11/09	<0.02	<0.02	<0.02	<0.02	<0.02
ST-02	7'	11/09	<0.02	<0.02	<0.02	<0.02	<0.02
ST-03	4'	11/09	<0.2	<0.2	<0.3	<0.3	230.
ST-05	4'	11/06	<0.01	<0.01	<0.02	<0.01	0.6
ST-06	2.5'	11/09	<0.02	<0.02	<0.02	<0.02	<0.02
ST-07	5'	11/09	<0.02	<0.02	<0.02	<0.02	<0.02
ST-07	5.5'	11/09	<0.02	<0.02	<0.02	<0.02	10
ST-08	2'	11/09	<0.02	<0.02	<0.02	<0.02	0.9
ST-10	3'	11/09	<0.02	<0.02	<0.02	<0.02	10
ST-11	5'	11/09	<0.02	<0.02	<0.02	<0.02	3
ST-12	3.5'	11/09	<0.02	<0.02	<0.02	<0.02	0.4
ST-13	4.5'	11/09	<0.02	<0.02	<0.02	<0.02	5
ST-14	5.5'	11/12	<0.02	<0.02	<0.03	<0.02	2
ST-15	3.5'	11/12	<0.02	<0.02	<0.03	<0.02	0.02

tations:
  interference with adjacent peaks
A not analyzed

Analyzed by M. Krotenberg

Checked by M. Krotenberg

GEOSCIENCE CONSULTANTS/TEXACO/TUTU, VIRGIN ISLANDS

Tracer Research Corporation

Sample	Depth	Date	Benzene (ug/l)	Toluene (ug/l)	Ethyl Benzene (ug/l)	Xylenes (ug/l)	Total Hydroc.w/o CH4 (ug/l)
SGT-16	5.5'	11/13	<0.02	<0.02	<0.03	<0.03	0.4
SGT-17	6'	11/13	<0.02	<0.02	<0.03	<0.03	0.2
SGT-17	6'	11/14	<0.02	<0.03	<0.03	<0.03	<0.02
SGT-18	5.5'	11/13	<0.02	<0.02	<0.03	<0.03	0.4
SGT-19	6'	11/13	<0.02	<0.02	<0.03	<0.03	0.2
SGT-19	10'	11/13	<0.02	<0.02	<0.03	<0.03	2
SGT-20	4.5'	11/14	<0.02	<0.03	<0.03	<0.03	0.2
SGZ-01	5'	11/11	I	<7	<7	<7	4,000
SGZ-02	3.5'	11/11	I	<52	<58	<54	28,000
SGZ-04	6'	11/11	I	<26	<29	<26	12,000
SGZ-05	5'	11/11	I	<5	<6	<5	860
Drift 1	4'	11/04	<0.02	<0.02	<0.03	<0.03	0.9
Drift 2	2.5'	11/05	<0.01	<0.01	<0.01	<0.01	0.1
Drift 3	2'	11/06	<0.01	<0.01	<0.02	<0.01	0.2
Drift 4	2'	11/09	<0.01	<0.01	<0.01	<0.01	0.2
Drift 5	2.5'	11/11	<0.02	<0.03	<0.03	<0.03	0.4
Drift 6	2'	11/12	<0.02	<0.02	<0.03	<0.02	0.4
Drift 6	2'	11/13	<0.02	<0.02	<0.03	<0.03	0.2
Drift 7	2'	11/14	<0.02	<0.03	<0.03	<0.03	0.4

Notations:
I interference with adjacent peaks
NA not analyzed

Analyzed by M. Krotenberg
Checked by M. Krotenberg

GEOSCIENCE CONSULTANTS/TEXACO/TUTU, VIRGIN ISLANDS

Tracer Research Corporation

Sample	Depth	Date	Ch2Cl2 (ug/l)	CHCl3 (ug/l)	TCA (ug/l)	CCl4 (ug/l)	TCE (ug/l)	PCE (ug/l)
SGH-01	3'	11/17	<0.9	<0.006	0.02	<0.0005	<0.004	1
SGH-02	3.5'	11/17	<0.9	<0.006	0.05	<0.0005	0.5	42
SGH-03	4'	11/17	<0.09	<0.0006	<0.0002	<0.00005	<0.0004	0.4
SGH-04	3.5'	11/17	<0.09	<0.0006	0.005	<0.00005	<0.0004	0.8
SGH-05	4'	11/17	<0.2	<0.001	<0.0004	<0.0001	0.05	6
SGH-06	4.5'	11/17	<30	<0.2	10	<0.02	<0.1	16
SGH-07	5'	11/17	<0.9	<0.006	0.04	<0.0005	0.6	170
SGH-08	5'	11/17	6	<0.006	<0.002	<0.0005	0.3	1
SGH-09	5.5'	11/17	<0.09	<0.0006	<0.0002	<0.00005	<0.0004	0.02

Notations:
1 interference with adjacent peaks
NA not analyzed

Analyzed by M. Krotenberg
Checked by M. Krotenberg

APPENDIX B

FIELD SYSTEM QUALITY ASSURANCE AUDIT
OF OPERATIONAL PROCEDURES

FIELD SYSTEM AUDIT OF OPERATIONAL PROCEDURES, SOIL GAS INVESTIGATION AT TEXACO TUTU SERVICE STATION, TUTU, ST. THOMAS, U.S. VIRGIN ISLANDS

Introduction

On November 6, 1987, a Field System Audit of the work being conducted by Geoscience Consultants, Ltd. (GCL) and Tracer Research Corporation (TRC) at the Tutu service station of Texaco Caribbean, Inc., on the island of St. Thomas, was performed by the GCL Quality Assurance (QA) Officer, Randall T. Hicks. The Field System Audit was conducted on the third day of soil gas sampling and analysis conducted by GCL and TRC at the Tutu site. Observations, recommendations, and corrective actions performed during the Field System Audit are described in this report.

Project History and Procedures

Texaco Caribbean, Inc. has contracted with GCL to conduct a soil gas investigation at the Tutu site in St. Thomas, U.S. Virgin Islands. The Tutu survey is designed to determine the levels of hydrocarbons which are found in soil gas from the areas surrounding underground storage tanks at the facility, to determine if a release has occurred from the tanks, and to assist in the definition of any soil or ground water contamination plumes.

Soil gas hydrocarbon values are determined by inserting a steel probe into the soil, withdrawing soil gas by use of a vacuum pump, and analyzing the gas for hydrocarbons using an on-site gas chromatograph (GC). Detailed descriptions for sampling and analytical procedures are in GCL's Work Plan and Quality Assurance Project Plan for the Tutu site (October 1987).

Field sampling and analytical procedures commenced at the Tutu site on November 3, 1987.

Purpose of Field System Audit

The Field System Audit was conducted to verify that procedures described in the Work Plan (WP) and Quality Assurance Project Plan (QAPP) were being adhered to in the field at the Tutu site, to determine whether any procedures required modification based on experience in the field, and to recommend any other procedural changes in field activities that might be necessary or desirable to improve the final work product.

Field Observations

No major technical problems were found with the work performed at the Tutu site. It was determined that significant difficulty exists using the current column and detector (OV-101 Column, Flame Ionization Detector) in the GC, as called for in the approved Work Plan and QAPP, to quantify benzene and toluene in soil gas. This could be the result of one of two situations:

- Benzene and toluene have selectively been flushed or biodegraded in the vadose zone, even in areas with significant total hydrocarbons as detected by the FID.
- Benzene and toluene are obscured by interference peak(s) and therefore not quantifiable with the presently used column in the GC.

In order to resolve this problem and to quantify the presence or absence of benzene and toluene in soil gas it was recommended, based on discussions between GCL, TRC, EPA and CDM-FPC (J. Appel - GCL; A.A. Gutierrez - GCL; Dan Evans - TRC; John Mihalich - CDM-FPC; Jim Ockalini-CDM - Boston), that a Carbopak 1000 column that will have a much longer retention time and allow a clean determination of the presence or absence of benzene and toluene be used at the Tutu site. It was agreed by all concerned that if this procedure failed to identify and quantify benzene and toluene, these constituents would be considered absent in soil gas. It must be noted, however, that this can be the case even though these constituents may be present in ground water, due to the biodegradation and flushing of the vadose zone and restriction of ground water to fractured bedrock. Furthermore it must be noted that, although the individual constituents have not been detected, the plume mapping using total hydrocarbons and detectable halocarbons on the electron capture detector (ECD) has been extremely successful over the majority of the site.

The principal technical problems were not encountered with the site work, but instead, with the site Work Plan and QAPP. Portions of the plans are not appropriate for actual site conditions. Other portions of the plans do not significantly add to accomplishing the goals of the project or were not being done routinely by TRC, and we recommended deletion of these practices from the QAPP and Work Plan. These recommended changes are summarized in Table 1.

Conclusions and Recommendations

The Field System Audit indicated that not all the procedures described in the WP and QAPP are followed exactly as planned previously due to site-specific conditions. The reasons for these discrepancies are valid and summarized in Table 1. Since the proposed changes to the Work Plan and QAPP tend to improve the quality and/or speed at which data can be collected during the project, it is recommended that the revised procedures, presently in use, be continued during further sampling and analysis and be incorporated into the Work Plan and QAPP for the Tutu site.

GCL is confident that the procedural revisions to the QAPP described in this report will result in improved data quality and a better final work product.

TABLE 1

RECOMMENDATIONS FOR CHANGES TO WORK PLAN AND QAPP

RECOMMENDED CHANGE	JUSTIFICATION FOR THE CHANGE	PAGE
Remove Russ Erbes from TRC.	Schleyer and Hicks will serve adequately for TRC.	1 (Q) Figure 2-1 (Q)
Do not employ PID Detectors in the Gas Chromatograph to conform with actual practice.	High humidity coupled with high levels of hydrocarbons will result in operational problems (clouding the window).	2 (Q) p.8 (WP)
Utilize a Carbopack 1000 column on selected samples.	BTEX concentrations were not determined with existing columns.	Appendix B, p.5 (Q)
Reference to NBS Standards should be deleted.	Standards are prepared by Chem Services, Inc pursuant to procedures outlined in Appendix B, p. 5.	5 (Q) 7 (Q)
The purpose of the control point should be stated in more detail.	It was unclear to field personnel. The control point is utilized to test for variability in analysis due to factors not related to any contamination (e.g., weather conditions, smog, etc.)	6 (Q)
Indicate that "preliminary" evaluation of data is conducted in the field.	Any statistical tests, detailed mapping and correlation of soil gas data with other hydrogeologic features will be conducted after all data are assembled into a logical format.	6 (Q)
Utilize a "one-point" Calibration for the GC, not a three point calibration as described. Justify the adequacy of this calibration which is presently being used in the field.	The one-point calibration is appropriate for soil gas surveys.	7 (Q)
The text addressing sample splits should be re-written for clarity.	Only one sample is taken from each point. After 10 samples, a selected point is repeated, sampled and analyzed.	p.9 (Q)
Appendix A should be retitled to read Tracer Research Corporation Methods of Operation for Soil Gas Analyses Using TRC's Mobile Laboratory and Probe Driver.	The title may suggest that the methods discussed will be used at Tutu. Most of the specific methods were modified to suit this remote location.	Appendix A (Q)
Appendix B should be modified throughout to reflect Actual Site Procedures.	Although this could not be fully anticipated, site conditions dictated special methods not described in the appendix (e.g., driving probes by hand, refrigeration of the standards).	Appendix B (Q)
Delete references to a second sample for each point to conform to actual practice.	It is not done and is not necessary.	Appendix B, p.1 (Q)
"Observations" should be made by GCL staff not TRC.	GCL staff is in a better position and it is GCL's responsibility to describe the site conditions for each sample point.	Appendix B, p.3 (Q)

TABLE 1 (CONTINUED)

RECOMMENDED CHANGE	JUSTIFICATION FOR THE CHANGE	PAGE
Obtain QA data on Chem Services Inc standards.	No data are provided.	Appendix B, p.6 (Q)
Dilute field standards should be refrigerated.	During field work variation of the standard was significant when not refrigerated.	Appendix B, p.6 (Q)
The water used to prepare the standard should be analyzed daily.	Distilled water from grocery stores has been found to contain hydrocarbons or halocarbons at other locations.	Appendix B, p.6 (Q)
Primary standards may be kept at the site to conform with actual practice.	No technical reason for keeping such standards off site was presented by site personnel.	Appendix B, p.7 (Q)
The syringe blank procedure should reflect field practice.	Field method is equivalent. A 10 ml syringe is filled with Nitrogen 2. Then a "micro" syringe is used to obtain a sample from the 1st syringe, the smaller sample is analyzed.	Appendix B, p.8, p.12 (Q)
System blanks may be run daily to conform with actual practice.	System blanks after every 10 samples is excessive and not necessary to assume quality of analytical results.	Appendix B, p.8, p.14 (Q)
Syringes and other equipment may be baked for 1/2 hour at 80°C rather than overnight at 70° to conform with actual practice.	The level of "Cleaning" is sufficient.	Appendix B, p.9, p.12 (Q)

note: (Q) = QAPP
(WP) = Work Plan

APPENDIX E

Alt #3. INSTALL DEEPER WELLS WITHIN THE CONTAMINATED AREA

I. EXTRAMURAL COSTS

A. ERCS Contractor Costs

a) Design Services			$ 20,000
		OH Mark Up	2,000
			$ 22,000
b) Mobilize (Three Days)			
Trailer	$1,300	mo.x3mo.	$ 3,990
Response Manager		55x8x3	1,320
Field Clerk		29x8x3	692
Electrician		33x8x3	792
(2) Cleanup Tech.		23x8x3x2	1,104
Travel			2,500
Rental Car			3,000
Subsistence			72,000
			$ 85,402
c) Deeper Well Installation			
Subcontractor (Three Wells)			$ 30,000
		OH Markup	3,000
			$ 33,000
d) Tie-In To House Piping (Three Days)			
Response Manager		55x8x3	$ 1,320
Field Clerk		29x8x3	696
(2) Cleanup Tech.		23x8x3	792
Material			500
			$ 3,308
e) Demobilize			$ 5,600
Subtotal, Extramural Direct Costs			$ 148,310

B. Contingency 30% (Include Other Allocable Costs Factor of 15%) — $ 44,493

Subtotal, Mitigation Cost — $ 192,803

C. TAT Costs

1046 hrs x 65/hr — $ 68,000

Subtotal, Extramural Direct Costs — $ 260,803

D. Contingency 15% of Above Costs — $ 39,120

Total, Extramural Costs — $ 299,923

II. Intramural Costs

Intramural Direct Costs (720+72 hours) x 30	$ 26,730
Intramural Indirect Costs 720 hours x 68	$ 48,600
Total, Intramural Costs	$ 75,330
Total Removal Ceiling Estimate	$ 375,253
SAY	$ 375,000

Alt #4. INSTALL A NEW WELL BEYOND THE AREA OF CONTAMINATION

I. EXTRAMURAL COSTS

A. ERCS Contractor Costs

a)	Design Services (Including Right of Ways)		$ 40,000
		OHM Mark Up	$ 4,000
			$ 44,000
b)	Mobilize (Three Days)		
	Trailer	$1,300 mo.x3mo.	$ 3,990
	Response Manager	55x8x3	$ 1,320
	Field Clerk	29x8x3	$ 692
	Electrician	33x8x3	$ 792
	(2) Cleanup Tech.	23x8x3x2	$ 1,104
	Travel		$ 2,500
	Rental Car		$ 3,000
	Subsistence		$ 72,000
			$ 85,402
c)	Well Installation (Subcontract)		$ 20,000
		OHM Mark Up	$ 2,000
			$ 22,000
d)	Extend Piping To Affected Homes (10,000 Feet) (50 Days)		
	Response Manager	55x8x50	$ 22,000
	Field Clerk	29x8x50	$ 11,600
	Subcontractor		$ 80,000
		OHM Mark Up	$ 8,000
			$121,600
e)	Tie In To House Piping (Three Days)		
	Response Manager	55x8x3	$ 1,320
	Field Clerk	29x8x3	692
	(2) Cleanup Tech.	23x8x3	792
	Material		500
			3,308
f)	Demobilize		$ 5,600
	Subtotal, Extramural Direct Cost		$278,202

B. Contingency 30% (Include Other Allocable Costs Factor of 15%) — $ 83,460

Subtotal, Mitigation Cost — $361,662

C. TAT Costs (720 Hours) — $ 46,800

Subtotal, Extramural Direct Costs — $408,462

D. Contingency 15% of Above Costs	$ 61,269
Total, Extramural Costs	$469,731
II. Intramural Costs	
Intramural Direct Costs (720 + 72 hours) x 30/hr	$ 26,730
Intramural Indirect Costs	$ 48,600
Total, Intramural Costs	$ 75,330
Total, Removal Ceiling Estimate	$545,061

Alt #5. WHOLE HOUSE REVERSE OSMOSIS

I. EXTRAMURAL COSTS

A. ERCS Contractor Costs

a)	Installation		
	3 R.O. units complete at $10,000 each	$	30,000
	R.O. Technician 7 days at $1,000 day	$	7,000
	Air Far Midwest-St. Thomas and return	$	1,000
		$	38,000
	OHM Markup	$	3,800
		$	41,800
b)	Electrician $33x8x7	$	1,848
	Response Manager 55x8x	$	3,080
	Field Clerk 29x8x7	$	1,624
	Materials	$	500
	Travel	$	2,500
	Rental Cars (2)	$	1,000
	Subsistence 3 persons x 7 days $200	$	4,200
		$	14,752
	Subtotal Extramural Direct Costs	$	56,852
c)	Maintenance (1 year)		
	8 Units at three days/visit x $100	$	24,000
	Materials	$	2,400
	12 Prefilters at 10 each	$	120
	Disposal Costs 2 family homes + 1 apartment complex 5,700 gpd x 365 day/year/55 gallon drum 37,832 55-gallon drums at $1,000/ drum		$37,832,000
	OHM Surcharge 10%	$	378,320
B.	Contingency 30% (Include Other Allocable Cost Factors of 15%)	$	17,056
	Subtotal Mitigation Costs	$	73,908
C.	TAT Costs 60 hours x $65/hr.	$	3,900
	Subtotal Extramural Direct Costs	$	77,808
D.	Contingency 15% of Above Costs	$	11,671
	Total Extramural Costs	$	89,479

II. Intramural Costs

Intramural Direct Costs (60 hours + 6 hours) x $30/hr.	$	1,980
Intramural Indirect Costs 60 x 68	$	4,048
Total, Intramural Costs	$	6,028
Total Ceiling Estimate	$	38,236,840
SAY	$	38,000,000

Alt #6. CONSTRUCT A WATER TREATMENT PLANT

I. EXTRAMURAL COSTS

A. ERCS Contractor Costs

a)	Design Services		$	30,000
		OHM Mark Up		3,000
			$	33,000
b)	Mobilize (Three Days)			
	Trailer	$1,300 mo.x3mo.	$	3,900
	Response Manager	55x8x3	$	1,320
	Field Clerk	29x8x3	$	692
	Electrician	33x8x3	$	792
	(2) Cleanup Tech.	23x8x3x2	$	1,104
	Travel		$	2,500
	Rental Car		$	3,000
	Subsistence		$	72,000
			$	85,402
c)	Construct Foundation (Ten Days)			
	Response Manager	55x8x10	$	4,400
	Field Clerk	29x8x10	$	2,320
	Subcontractor		$	15,000
		OHM Mark Up	$	1,500
			$	23,220
d)	Install Treatment Plant (10 days)			
	Response Manager	55x8x10	$	4,400
	Field Clerk	29x8x10	$	2,320
	Subcontractor		$	20,000
		OHM Mark Up	$	2,000
	Treatment Plant		$	15,000
			$	43,720
e)	Extend Piping From Plant To Affected Homes Area (Based On) Installation Of 1,000 feet of 4" Dip) (Fifteen Days)			
	Response Manager	55x8x15	$	6,600
	Field Clerk	29x8x15	$	3,480
	Subcontractor		$	20,000
		OHM Mark Up	$	2,000
			$	32,080
f)	Tie In To House Piping (Three Days)			
	Response Manager	55x8x3	$	1,320
	Field Clerk	29x8x3	$	696
	(2) Cleanup Tech.	23x8x3	$	792
	Material		$	500
			$	3,308
g)	Demobilize		$	5,600
	Subtotal, Extramural Direct Costs		$	224,830

B.	Contingency 30% (Include Other Allocable Costs Factor of 15%)	$	67,449
	Subtotal, Mitigation Cost	$	292,279
C.	TAT Costs (45 Days)	$	23,400
	Subtotal, Extramural Direct Costs	$	315,679
D.	Contingency 15% of Above Costs	$	47,351
	Total, Extramural Costs	$	363,030
II.	Intramural Costs		
	Intramural Direct Costs (360 + 36 hours)	$	11,880
	Intramural Indirect Costs	$	24,448
	Total, Intramural Costs	$	36,360
	Total, Removal Ceiling Estimate	$	399,390
	SAY	$	400,000

Alt #7. CONSTRUCT A REVERSE OSMOSIS CENTRAL PLANT

I. EXTRAMURAL COSTS

A. ERCS Contractor Costs

a)	Design Services		$	30,000
		OHM Mark Up		3,000
			$	33,000
b)	Mobilize (Three Days)			
	Trailer	$1,300 mo.x3mo.	$	3,900
	Response Manager	55x8x3	$	1,320
	Field Clerk	29x8x3	$	692
	Electrician	33x8x3	$	792
	(2) Cleanup Tech.	23x8x3x2	$	1,104
	Travel		$	2,500
	Rental Car		$	3,000
	Subsistence		$	72,000
			$	85,402
c)	Construct Foundation (Ten Days)			
	Response Manager	55x8x10	$	4,400
	Field Clerk	29x8x10	$	2,320
	Subcontractor		$	5,000
d)	Install Central Plant (Ten Days)			
	Response Manager	55x8x10	$	4,400
	Field Clerk	29x8x10	$	2,230
	Subcontractor		$	4,400
	Central Plant		$	24,720
e)	Extend Piping From Plant To Affected Homes Area (Based On) Installation Of 1,000 feet of 4" Dip) (Fifteen Days)			
	Response Manager	55x8x15	$	6,600
	Field Clerk	29x8x15	$	3,480
	Subcontractor		$	20,000
		OHM Mark Up	$	2,000
			$	32,080
f)	Tie In To House Piping (Three Days)			
	Response Manager	55x8x3	$	1,320
	Field Clerk	29x8x3	$	696
	(2) Cleanup Tech.	23x8x3	$	792
	Material		$	500
			$	3,308
g)	Demobilize		$	5,600
	Subtotal, Extramural Direct Costs		$	205,830

B. Contingency 30% (Include Other

	Allocable Costs Factor of 15%)	$	61,749
	Subtotal, Mitigation Cost	$	267,579
C.	TAT Costs (45 Days)	$	23,400
	Subtotal, Extramural Direct Costs	$	290,979
D.	Contingency 15% of Above Costs	$	43,646
	Total, Extramural Costs	$	334,625
II.	Intramural Costs		
	Intramural Direct Costs (360 + 36 hours)	$	11,880
	Intramural Indirect Costs	$	24,480
	Total, Intramural Costs	$	36,360
	Total, Removal Ceiling Estimate	$	370,985
	SAY	$	375,000

Alt #8. INCREASE THE CAPACITY OF THE CISTERNS

I. EXTRAMURAL COSTS

A. ERCS Contractor Costs

a) Design Services			
Three Cisterns		$	18,000
	OHM Mark Up		1,800
		$	19,800
b) Mobilize (Three Days)			
Trailer	$1,300 mo.x3mo	$	3,990
Response Manager	55x8x3	$	1,320
Field Clerk	29x8x3	$	692
Electrician	33x8x3	$	792
(2) Cleanup Tech.	23x8x3x2	$	1 104
Travel		$	2,500
Rental Car		$	3,000
Subsistence		$	72,000
		$	85,402
c) Enlarge Cisterns (Thirty Days) (Includes Removing Existing Cistern, Shoring the open hole, installation of a 5 foot Deeper Cistern)			
Response Manager	55x8x30	$	13,200
Field Clerk	29x8x30	$	6,960
Subcontractor		$	60,000
	OHM Mark Up	$	6,000
		$	86,160
		$	5,600
d) Demobilize			
Subtotal, Extramural Direct Costs		$	196,962
B. Contingency 30% (Include Other Allocable Costs Factors of 15%)		$	59,088
Subtotal, Mitigation Costs		$	256,050
C. TAT Costs (45 Days)		$	23,400
Subtotal, Extramural Direct Costs		$	279,450
D. Contingency 15% of Above Costs		$	41,971
Total, Extramural Costs		$	321,368

II. Intramural Costs

Intramural Direct Costs (720 + 72 hours)	$	11,880
Intramural Indirect Costs	$	24,480
Total, Intramural Costs	$	36,360

Total, Removal Ceiling Estimate	$	357,728
SAY	$	360,000

Alt #9. ACTIVATED CARBON UNITS

II. EXTRAMURAL COSTS

A. ERCS Contractor Costs

a) Installation

Three carbon filters (6 units) at 11,000/filter	$	33,000
Technician three days at $500/day	$	1,500
Travel, San Juan P.R. To St. Thomas	$	200
and return	$	37,700
OHM Mark Up	$	3,470
	$	38,170
b) Response Manager 55x8x5	$	2,200
Field Clerk 29x8x5	$	1,160
Travel	$	1,000
Rental Car (2)	$	500
Subsistence 2x5x200	$	2,000
	$	6,860
c) Maintenance (1 year) Assume Two Carbon Changes Per Column Per Year		
Technician 4 visits $1,000/visit	$	4,000
Carbon change 2 times at $1,000	$	2,000
Disposal costs Three drums at $3,000	$	9,000
Subtotal	$	15,000
OHM Surcharge	$	1,500
	$	16,500
Subtotal, Extramural Direct Costs	$	61,530
B. Contingency 30% (Include Other Allocable Costs Factors of 15%)	$	18,460
Subtotal, Mitigation Costs	$	79,990
C. TAT Costs (40 hours x $65/hour	$	2,600
Subtotal, Extramural Direct Costs	$	82,590
D. Contingency 15% of Above Costs	$	12,390
Total, Extramural Costs	$	14,980

II. Intramural Costs

Intramural Direct Costs (40 hours + 4) x $30/hr.	$	1,320

Intramural Indirect Costs 40 x $68/hr	$	2,720
Total, Intramural Costs	$	4,040
Total, Removal Ceiling Estimate	$	100,000